U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF CHEMISTRY—BULLETIN NO. 78.

H. W. WILEY, CHIEF.

THE INFLUENCE OF ENVIRONMENT

UPON THE

COMPOSITION OF THE SUGAR BEET, 1902,

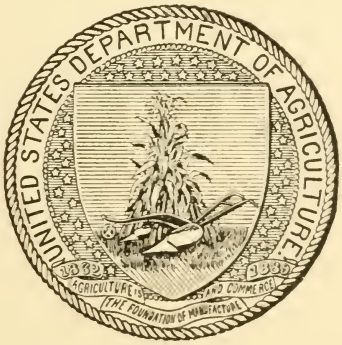
INCLUDING A STUDY OF IRRIGATED SECTIONS.

BY

HARVEY W. WILEY,

CHIEF OF BUREAU,

IN COLLABORATION WITH THE WEATHER BUREAU AND THE AGRICULTURAL EXPERIMENT STATIONS OF CALIFORNIA, COLORADO, INDIANA, KENTUCKY, MICHIGAN, NEW MEXICO, NEW YORK, UTAH, VIRGINIA, AND WISCONSIN.



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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Chemistry,
Washington, D. C., June 30, 1903.

Sir: I have the honor to transmit for your approval a manuscript, accompanied by graphic charts, embodying the results of the cooperative work conducted by this Bureau on the study of the effect of environment upon the composition of the sugar beet during the year 1902, and to recommend its publication as Bulletin 78 of the Bureau of Chemistry. This is a continuation of the work of 1900, the results of which were published in Bulletin 64, and of 1901, reported in Bulletin 74.

In this connection I desire to express the appreciation of this Bureau of the collaborative work done by the various experiment stations taking part in the experiment; of the continued cooperation of the Weather Bureau, without which it would be very difficult, if not impossible, to collect the meteorological data; and of the information furnished by the United States Coast and Geodetic Survey and the Naval Observatory. The analytical work done in this Bureau on the beets was performed by Messrs. Houghton and Given; that on the soils by Messrs. Veitch and Trescot; while the mechanical analyses were made by the Bureau of Soils.

Respectfully,

H. W. Wiley, *Chief.*

Hon. James Wilson,
Secretary of Agriculture.

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ORGANIZATION OF COLLABORATIVE WORK.

In the third year of the cooperative experiments with the sugar beet two series of experiments were conducted, one with stations where irrigation was practiced and the other with the nonirrigated stations at which the work has been carried on for two years. The consideration of the soils in which the beets were grown, which was begun in a tentative manner in 1901, was continued and a more complete study was made of this phase of the environment, two additional charts being added to show the relation of the more important plant foods and the physical condition of the soil to the yield per acre.

On February 28, 1902, the following letter was sent to the stations at Logan, Utah; Fort Collins, Colo.; Mesilla Park, N. Mex.; Tucson, Ariz.; Laramie, Wyo.; Moscow, Idaho; Berkeley, Cal.; Pullman, Wash., and Corvallis, Oreg., at which irrigation would probably be practiced:

DEAR SIR: It is desirable to extend the studies of the influence of environment on the constitution of the sugar beet to areas where irrigation is practiced. The scope of these studies and the methods of conducting them are sufficiently outlined in Bulletin 64 of this Bureau, a copy of which is inclosed.

I desire to have your cooperation in these studies and feel very sure that great good will come of them, not only to the beet-sugar industry, but to agriculture in general. The extent of the collaboration is sufficiently shown in Bulletin 64. If you are willing to engage in these collaborative studies, I beg you to inform me at an early date. The necessary seeds for planting and uniform directions for culture and irrigation will be prepared and forwarded as soon as your acceptance is received. I send this letter with the full approbation of Mr. Elwood Mead, in charge of the irrigation work of the Department of Agriculture, who would have joined me in the signature had he not been absent from the city.

Respectfully, H. W. WILEY, *Chief.*

Of the stations to which this letter was sent, five—namely, those of Utah, Wyoming, California, Colorado, and Idaho—consented to take part in the experiment. Only three reports are given, however, as the Wyoming crop was a failure and the work done at the Idaho station was not comparable with the other experiments, no irrigation being practiced. The request reached the Arizona station too late in the season for acceptance.

To the stations which had previously cooperated in the work, namely, those of North Carolina, Iowa, Michigan, Virginia, Indiana, Wisconsin, Kentucky, and the two New York stations, the following letter was sent:

MARCH 7, 1902.

DEAR SIR: The good results which have attended the collaborative work in the study of the effect of environment upon sugar beets, and the high commendations thereof which have been received from many practical sources, lead me to believe that a continuance of this work would be highly beneficial. The Weather Bureau has promised to continue its collaboration, and I desire to ask you to undertake again work similar to that which you have done in this direction the past two years. Seeds of high grade and with a germinating power of high quality, as tested in this Department, will be sent to you, as heretofore, for experimental work. The character of the experiments is sufficiently outlined in Bulletin 64, a copy of which I send inclosed.

Hoping that I may have a favorable reply, I am,

Respectfully, H. W. WILEY, *Chief.*

The North Carolina station, which had withdrawn from the work in 1901, was again unable to cooperate, and the work was also temporarily discontinued at Ames, Iowa, on account of a change in the station force.

The following letter containing complete instructions as to the conduct of the experiment, the sampling of the soil, records to be kept, etc., together with an additional note for the stations practicing irrigation, was sent to all cooperating stations at the opening of the season:

APRIL 15, 1902.

DEAR SIR: For the collaborative work in the study of the influence of environment on the composition of the sugar beet, for the present year, I have decided to use seed No. 8238, and a package of this number has been sent to you for such collaborative work.

The area planted need not exceed an eighth of an acre, unless you desire a larger area or a number of plats. This matter is left entirely to your own judgment, and the residue of the seed you can dispose of as you like. I suggest, however, that the special plat be seeded very heavily so as to be sure of a good stand, and that enough of the seed be reserved for replanting in case the first planting should not germinate.

The soil some time before sowing, preferably the previous autumn, should be plowed to the usual depth of 8 or 9 inches and subsoiled to at least 6 inches more, making a seed bed of at least 15 inches in depth. If the character of the soil warrants it, a deeper plowing, even to 10 or 11 inches, and a subsoiling of 6 inches additional, will be advisable.

The surface of the soil should be reduced to a fine tilth and well harrowed and stirred immediately before planting so as to stop all growth of weeds which may have started. The rows should be 18 inches apart and the seed planted at the rate of about 25 pounds per acre, so as to be sure of a good stand. If the soil be moist the seed should be covered to a depth of from one-half to 1 inch. If the weather be dry, slightly deeper planting may be advisable.

As soon as the plants are vigorously growing, they should be "bunched" by a hoe 6 inches in width, leaving the length of 3 inches of beets in each hill. When the beets have a vigorous growth and begin to form the fourth leaf, they should be thinned to about one plant in each 9 inches. Where vacancies occur in a row, transplant carefully so as to have the number of plants indicated.

Ordinary surface cultivation is all that is required, being careful not to cover up the beets at the first cultivation.

In connection with this study, I desire to make careful chemical and physical analyses of the soils of the plats used for the growing of the beets. I therefore ask that you take a representative sample of the soil and subsoil of the plat on which you grow the No. 8238 seed during the present year. After getting a representative sample reduce it in size by quartering or otherwise so as to secure a representative subsample weighing not more than 4 pounds, and send it, under the inclosed frank, by mail to my address.

In sending the sample of soil in accordance with the above instructions, do not forget to send a history of the plat so far as known. Complete cultural and meteorological data, in collaboration with the Weather Bureau, should be kept and forwarded with the samples. Franks for forwarding the samples and full instructions for sampling and harvesting will be sent later. It is earnestly requested that frequent analyses be made at the station, so that the results of those analyses can be compared with those which are made of the beets sent here.

Any questions in regard to further details will be promptly answered.

Respectfully,

H. W. Wiley, *Chief.*

The note to the stations using irrigation was as follows:

IRRIGATED PLATS.

If irrigation is practiced it is desirable that a record be kept of the number of times water is applied and the amount used each time.

In regard to the details of irrigation I can not offer any suggestions, since I have had no experience whatever with irrigated plats. It appears to me that the important thing is to secure the regular and uninterrupted growth of the beets until maturity or near maturity, so that they can ripen without any danger of undergoing a second growth.

In these experiments the temperature record is of more than ordinary importance, since there is some ground for believing that a beet of excellent sugar content can be produced under irrigation where the mean temperature is much higher than is favorable to the production of a good beet in regions under ordinary cultivation.

Since this is the first collaborative experiment in this country undertaken in irrigated areas, suggestions for the second year's work are respectfully solicited.

The seed used in this experiment, referred to as S. P. I. No. 8238, was the Kleinwanzlebener Nachzucht, produced by H. Bennecke & Son, at Athensleben bei Löderburg, Germany, and transmitted to this Department through Ernst Anders, of Magdeburg, for use in this experiment. Mr. Anders, in transmitting the seed, said:

The high germinating power is a very important thing, guaranteeing a quick and equal start, regular growth, and finally a high tonnage. Please take in consideration that the sugar produced per acre will be increased to a very high amount by this fact, notwithstanding the percentage of sugar in the beets may be a little smaller in comparison with other high-grade beet seed giving a smaller tonnage. * * *

Furthermore, the power to germinate very quickly is very important in cases of destruction of the small plants by insects, or if the preparation of the fields is not finished in the proper time, as in either case a late drilling becomes necessary.

The germinating tests of the seed made in the laboratory of Seed and Plant Introduction, Bureau of Plant Industry, of this Department,

gave a germination of 80 per cent of seed balls, 196.5 sprouts from 100 seed balls, with 106,000 sprouts from 1,000 grams of seed, thus fully justifying the remarks of Mr. Anders concerning its vitality.

When the time for harvesting approached the following letter was addressed to the cooperating stations:

SEPTEMBER 9, 1902.

DEAR SIR: We are about to begin our analytical work on samples of sugar beets grown from the special seed No. 8238. This is the seed that I requested you to plant for the collaborative work in a study of the influence of environment on the composition of the beet. If practicable I would like you to follow the plan outlined below in obtaining samples of beets.

Harvest every beet in 50 feet of an inside row; wash, dry, and weigh the beets after removing the leaves, but not the crown or neck. Report the estimated yield per acre based upon the weight of the beets (not topped) from 50 feet of row. Forward to this Bureau by express, charges collect, about twenty-five average beets (not topped) from those harvested. Please weigh the beets before shipment, that we may calculate the loss in weight during transit to Washington. We shall use your estimated tonnage and the percentage of loss in topping in estimating the net yield per acre.

Please repeat this work every week until the end of the season. An identification slip giving date, name of station, and the weights and data requested above should be inclosed with each sample. With the first sample forward agricultural data.

Begin sampling on receipt of this letter, not awaiting full maturity of the beets. From time to time I will report the results of the analyses of the samples to you.

Trusting that it will be convenient for you to continue the cooperative work as outlined above, I am,

Respectfully, H. W. WILEY, *Chief.*

To distant stations cooperating in the work the following additional suggestions were made:

Since your experimental fields are so far from our laboratory, I would be very glad if you could arrange to have these analyses made at your station. If you can not do this, it will be necessary to subsample the beets harvested, report the agricultural data, and pack a carefully weighed quantity of untopped beets in a box and ship them to this laboratory, reporting the weight shipped. In this event about twenty beets should be sent.

I trust that it will not be necessary to forward these samples, as the results will be much more satisfactory if obtained with the fresh material at your laboratory.

These data should be obtained from the beets grown on both the irrigated and non-irrigated plats.

EXPERIMENTS CONDUCTED IN HUMID REGIONS.

POTOMAC FLATS, WASHINGTON, D. C.

Two series of experiments were carried on at the Department farm, Potomac flats. Each consisted of four plats, with dates of planting varying from April 18 to May 30, and in one series irrigation was practiced. The cultural data, except as to irrigation, were the same for both series of plats and are given as follows:

Plat 1.—Planted April 18; up April 22; thinned to two in a hill April 28, 29; thinned to one in a hill on May 14. The plat was cultivated with a wheel hoe on April 25, May 2, 8, 16, 26, June 12, and June 25, when the crop was laid by.

Plat 2.—Planted May 2; up May 8; thinned to two in a hill May 16; thinned to one in a hill May 24. The plat was cultivated on May 16, 26, June 12, 25, 30, and July 2, when the crop was laid by.

Plat 3.—Planted May 16; up May 20; thinned to one in a hill June 6. The plat was cultivated on May 26, June 6, 12, 18, 25, 30, July 5, and July 11, when the crop was laid by.

Plat 4.—Planted May 30; up June 10 (up where irrigated June 5); thinned to one in a hill June 24. The plat was cultivated on June 12, 18, 25, 30, July 5, and July 11, when the crop was laid by.

Each plat or planting consisted of 12 rows, each 25 rods long. The seeds were run in with a seed drill having the dropping attachment set to 9 inches, the rows being 18 inches apart. The plants were thinned as soon as the seedlings were large enough to handle.

The following record shows the amount of moisture received by the irrigated plats from both rainfall and irrigation. By leaving out of consideration the dates followed by the expression (I), which indicates moisture received by irrigation, the amount of water received by the nonirrigated plats can be determined.

1902.	Inches.	
April 29	0.21	
30	.11	
Total		0.32
May 3	0.36	
	0.16	
	.06	
	.98	
	1.18	
	.65	
	1.93	
	.35	
Total		5.67
June 2 (I)	0.50	
5 (I)	.50	
7	.57	
11	.15	
12 (I)	.50	
16	.93	
19 (I)	.50	
19	.21	
21	1.22	
25	.05	
26	1.60	
30	.37	
Total		7.10

1902.	Inches.	
July 3 (I)	0.50	
5 (I)	.25	
9	.45	
14 (I)	.60	
16 (I)	[a].45	
18	1.31	
19	Trace.	
20	.19	
21	.22	
24	.16	
30	.75	
31	.70	
Total		5.58
Aug. 4	0.25	
6	.94	
10	1.02	
23	.20	
26	.38	
27	.04	
Total		2.83
Sept. 3	1.03	
9	1.65	
Total		2.68
General total		24.18

[a] Applied to plats Nos. 3 and 4 only.

The analytical and field data, determined for the different plats grown under varying conditions, are shown in the following table:

Agricultural and analytical data on beets grown on the Potomac flats, District of Columbia, showing averages for different dates of planting.

UNIRRIGATED.

Plat No.	Date planted.	Average weight after topping.	Estimated yield per acre.	Sugar in juice.	Sugar in beet.	Purity coefficient.
	1902.	*Ounces.*	*Tons.*	*Per cent.*	*Per cent.*	
1	Apr. 18	18.6	27.9	9.1	8.3	72.3
2	[a]May 2	22.9	26.1	9.2	8.4	72.4
3	May 16	10.6	19.6	9.3	8.5	72.4
4	May 30	9.9	14.4	9.3	8.6	72.1
Average		15.5	22	9.2	8.5	72.3

IRRIGATED.

1	Apr. 18	23.5	18.3	7.7	7.1	67.9
2	May 2	25.4	15.8	8.0	7.4	69.5
3	May 16	12.5	10.8	8.7	8.0	71
4	May 30	12.9	10.8	8.9	8.1	70.5
Average		18.6	13.9	8.3	7.7	69.7

[a] The data for May 2, unirrigated, are platted.

The climatic conditions under which this crop was grown are shown by the following data:

Meteorological data for Washington, D. C.

Month.	Mean temperature.	Precipitation.	Sunshine.			Clear days.	Cloudy days.
			Actual.	Possible.	Per cent.		
1902.	° *F.*	*Inches.*	*Hours.*	*Hours.*			
May	65.4	3.35	290.0	443.8	65	13	4
June	71.8	3.70	306.3	445.9	69	14	5
July	77	2.54	304.6	453	67	11	3
Average and total	71.4	9.59	.....	.....	67	38	12
August	72.6	1.85	321	423.2	76	11	4
September	66.8	5.30	218.4	373.4	58	13	3
October	57.6	6.76	229.1	346	66	18	6
Average and total	65.7	13.91	.....	.....	67	42	13
General average and sum total	68.6	23.50	.....	.....	67	80	25

The rather contradictory data relative to the yields of the unirrigated and irrigated plats call for a word of explanation. The irrigated plats were located at the west end of the field, the rows of beets running east and west. Unfortunately the stand of beets upon this end was not so good as on the central and western portions of the area planted with beets. There were some places in the rows where beets failed to grow, and thus in thinning fewer beets were left in a given length of row on the irrigated than on the unirrigated portion. A single illustration taken at random will illustrate this. On September 16,

50 feet harvested from each of the four plats planted on April 18, May 2, May 16, and May 30 gave the following number of beets respectively: 59, 49, 60, and 54—total, 222. On the same day 50 feet in length from each of the four rows of irrigated beets yielded the following number of beets: 26, 26, 33, and 23—a total of 108, or less than one-half as many as were yielded by the unirrigated plats. This is of course an extreme case, but the same general proportions as to the number of beets harvested on the two plats obtained throughout the season. This condition explains the apparent contradiction in the yields of the two plats since the unirrigated portions, although the beets weighed less, yielded a larger tonnage than the irrigated plats.

By reason of the larger size of the beets on the irrigated area it is not surprising that they were inferior both in sugar content and in purity to those taken from the unirrigated areas. It does not appear that the practice of irrigation had any effect upon the crop. In fact, it was a most unfavorable season to show any good effect of irrigation, since the rainfall, with the one exception of the month of August, was entirely sufficient in quantity and was advantageously distributed. The excess of rainfall in September and October of course had a tendency to continue the growth and retard the period of maturity. Nevertheless, the beets produced were decidedly superior to those of preceding years. This is probably explained by the fact that the mean temperature of the six growing months in 1900 was 71.7°; in 1901, 69°; and in 1902, 68.6°—a steady though slight decrease.

THE INDIANA STATION.

Unfortunately there are no data to be presented for the Indiana station as the crop was a complete failure. Director Huston comments on this fact under date of January 16, 1903, as follows:

> The seed which was received from you was planted upon ground carefully prepared and germinated satisfactorily. On May 20 the beets were up and showing a good stand. On June 10 there were practically no live beets in the field, and Mr. Jones at once had a portion of the field replanted with the reserved seed. This planting also germinated reasonably well, but the enormous rainfall in June destroyed the young beets, so that there was practically nothing left upon the field. We later put soy beans on the field and they failed to grow. I am rather at a loss to understand what was the cause of these failures, as the field had been under two different crops since beets had been raised upon it. I am under the impression that the first planting was injured by the first cultivation, but as the man who attended to it is not here I am unable to be sure that this was the real cause. Last year a crop of soy beans was plowed under on this land and I thought it was in fine condition and had arranged to irrigate a portion of the field and had all the pipes in place for this purpose. Since the failure of the crops on this piece of ground this spring it has been kept in fallow, and I will have it thoroughly prepared this fall and think it ought to be in first-class condition for the beet work next year.

The meteorological data for this season at Lafayette and at Indianapolis, 59 miles to the southeast, are given in the following tables:

Meteorological data for Lafayette, Ind.

Month.	Mean temperature.	Precipitation.	Sunshine.			Clear days.	Cloudy days.
			Actual.	Possible.	Per cent.		
1902.	° *F.*	*Inches.*	*Hours.*	*Hours.*			
May	65.3	3.64	.....	.....	.....	7	16
June	68.4	11.37	.....	.....	.....	5	15
July	74.8	6.56	.....	.....	.....	11	8
Average and total	69.5	21.57	.....	.....	.....	23	39
August	70.1	1.40	.....	.....	.....	12	13
September	63.3	3.72	.....	.....	.....	10	15
October	56.1	3.27	.....	.....	.....	10	7
Average and total	63.2	8.39	.....	.....	.....	32	35
General average and sum total	66.4	29.96	.....	.....	.....	55	74

Meteorological data for Indianapolis, Ind.

Month.	Mean temperature.	Precipitation.	Sunshine.			Clear days.	Cloudy days.
			Actual.	Possible.	Per cent.		
1902.	° *F.*	*Inches.*	*Hours.*	*Hours.*			
May	66.0	3.66	300.8	446.7	67.0	4	3
June	69.5	7.52	282.6	449.0	63.0	9	8
July	75.8	3.67	330.9	455.2	73.0	10	3
Average and total	70.4	14.85	.....	.....	67.7	23	14
August	71.6	2.09	262.2	425.2	62.0	10	3
September	64.4	5.33	190.3	373.6	51.0	8	9
October	57.4	2.36	214.1	344.9	62.0	9	5
Average and total	64.5	9.78	.....	.....	58.3	27	17
General average and sum total	67.5	24.63	.....	.....	63.0	50	31

THE KENTUCKY STATION.

The same plat that had been used for the beet experiments in 1900 and 1901 was again assigned for that work in 1902. The land was plowed on April 16, replowed and subsoiled 20 inches deep on April 22. The soil was put in perfect tilth with a smoothing harrow and roller. The seed were planted on the same day about 1 inch deep in rows 18 inches apart, a hand drill being used. The plants were up on April 30, and were cultivated as follows: May 9, hoed; May 14, hoed and plowed; May 21, thinned to 6 inches, hoed and plowed; May 28, thinned to 9 inches and cultivated. At the latter date there was almost a perfect stand, and plants were transplanted to fill the few vacancies that occurred. Throughout the growing season the beets were cultivated once every two weeks.

The early growth of the crop was very vigorous, and the season

until September 1, was favorable. During September and October the beets grew very little, but a considerable growth took place in November.

The analytical data on the samples taken as determined both at Washington and at Lexington are given in the following tables:

Agricultural and analytical data on beets grown at Lexington, Ky.

Date received.	Average weight after topping.	Estimated yield per acre.	Sugar in juice.	Sugar in beet.	Purity coefficient.
1902.	*Ounces.*	*Tons.*	*Per cent.*	*Per cent.*	
September 18	8.0	10.0	9.3	8.6	74.6
October 9	8.6	9.0	7.4	6.8	68.5
October 21	8.0	8.0	7.5	6.9	70.7
October 25	7.2	8.4	7.6	7.0	69.7
Average	8.0	8.9	8.0	7.3	70.9

Sugar beets grown and analyzed at Lexington, Ky.

Date of sampling.	Number of beets taken.	Average weight after topping.	Sugar in the juice.	Sugar in the beet.[a]	Purity coefficient.
1902.		*Ounces.*	*Per cent.*	*Per cent.*	
June 25	7	4.7	8.15	7.50	65.7
August 6	12	12.4	9.53	8.77	73.8
August 19	9	13.7	9.30	8.56	72.3
October 4	4	9.2	7.15	6.58	66.0
October 13	5	8.8	4.75	4.37	57.2
October 21	6	10.0	6.92	6.37	66.1
December 4	6	17.1	8.77	8.07	67.0
December 8	5	14.6	8.38	7.71	67.6
Average		11.3	7.87	7.24	67.0

[a] Calculated at Washington, D. C.

The meteorological conditions existing during the growing season of 1902 at Lexington are shown in the following table:

Meteorological data for Lexington, Ky.

Month.	Mean temperature.	Precipitation.	Sunshine.			Clear days.	Cloudy days.
			Actual.	Possible.	Per cent.		
1902.	° *F.*	*Inches.*	*Hours.*	*Hours.*			
May	68.2	2.43	364.5	441.7	83.0	18	0
June	71.2	5.19	359.3	443.1	81.0	13	4
July	76.8	2.33	361.4	450.1	80.0	14	0
Average and total	72.1	9.95			81.1	45	4
August	73.8	1.89	330.4	422.1	78.0	13	2
September	67.0	2.60	245.1	373.0	66.0	10	7
October	59.0	2.11	241.2	347.3	69.0	15	9
Average and total	66.6	6.60			71.0	38	18
General average and sum total	69.3	16.55			76.1	83	22

The following table, compiled at the Kentucky station, shows the averages in temperature and precipitation for fifteen years prior to 1903, and also the accumulated deficiency of precipitation from January 1, 1902:

Averages for fifteen years, and accumulated rainfall deficiency.

Meteorological data.	May.	June.	July.	Aug.	Sept.	Oct.
Temperature.....degrees F..	64	74	76	74	69	57
Precipitation.....inches..	3.71	4.31	4.06	3.95	2.59	2.11
Accumulated rainfall deficiency from Jan. 1, 1902–Jan. 1, 1903.[a].....inches..	7.36	6.39	8.12	10.18	10.17	10.17

[a] The accumulated deficiency of precipitation for the preceding year, 1901, was 13.28 inches.

Under date of February 11, 1903, Mr. A. M. Peter, chemist of the station, forwarded some additional data obtained on beets from the experimental plat which were harvested in the second week of November and stored in a cellar until January 31, 1903, when they were sampled and the following analyses made:

Data determined on beets stored for two months at Lexington, Ky.

Station number.	Number of beets.	Weight of beet.		Sugar in juice.	Purity.
		Topped.	Trimmed.		
		Ounces.	*Ounces.*	*Per cent.*	
10892	1	16.2	13.2	7.4	72.6
10893	1	15.7	12.0	7.2	59.5
10894	1	15.0	12.5	9.95	71.8
10895	1	16.8	11.8	9.1	72.2
10896	1	13.0	10.5	8.1	65.3
10897	2	10.1	7.9	9.55	71.8
Average		14.5	11.3	8.6	68.9

The results of the experiment at the Lexington station are particularly interesting in that they have again robbed the Washington station of its original position at the foot of the ladder in the production of beets of a low sugar content. The precipitation at Lexington, while below the average, appears to have been sufficient for the needs of the crop. The month of August, however, as at Washington, was somewhat dry. The average temperature for the six growing months was 69.3° or 0.7° higher than at Washington.

THE MICHIGAN STATION.

Under date of May 16, 1902, Director Smith reported that the beets were up and large enough to be cultivated within a week. The season was wet and cold, frosty nights occurring especially during May. The crop harvested was of very high quality, however, as is shown by the following table:

Agricultural and analytical data on beets grown at Agricultural College, Mich.

Date received.	Average weight after topping.	Estimated yield per acre.	Sugar in juice.	Sugar in beet.	Purity coefficient.
1902.	*Ounces.*	*Tons.*	*Per cent.*	*Per cent.*	
September 20	10.9	.....	15.1	13.9	82.1
September 27	10.9	.....	15.0	13.8	86.7
October 7	10.2	12.8	14.4	13.2	86.2
October 14	10.2	12.0	14.4	13.2	86.7
October 21	11.5	14.5	14.8	13.6	87.6
October 28	12.5	.....	15.2	13.9	89.4
November 4	8.3	10.5	15.0	13.8	89.3
Average	10.6	12.5	14.8	13.5	86.9

The meteorological data for Agricultural College and for Detroit, 76 miles to the southeast of the college station, are given in the following tables, the sunshine record not being available for any point nearer to Agricultural College than Detroit:

Meteorological data for Agricultural College, Mich.

Month.	Mean temperature.	Precipitation.	Sunshine.			Clear days.	Cloudy days.
			Actual.	Possible.	Per cent.		
1902.	°*F.*	*Inches.*	*Hours.*	*Hours.*			
May	58.4	4.92	.....	.....	.....	6	11
June	61.8	7.28	.....	.....	.....	9	19
July	70.6	7.13	.....	.....	.....	.....	.....
Average and total	63.6	19.33	.....	.....	.....	15	30
August	64.2	.68	.....	.....	.....	11	7
September	58.7	5.88	.....	.....	.....	11	17
October	49.6	1.53	.....	.....	.....	18	13
Average and total	57.5	8.09	.....	.....	.....	40	37
General average and sum total	60.5	27.42	.....	.....	.....	55	67

Meteorological data for Detroit, Mich.

Month.	Mean temperature.	Precipitation.	Sunshine.			Clear days.	Cloudy days.
			Actual.	Possible.	Per cent.		
1902.	°*F.*	*Inches.*	*Hours.*	*Hours.*			
May	58.4	3.52	298.7	451.9	66	12	6
June	63.9	6.97	235.6	456.2	52	5	9
July	72.8	7.55	291.9	461.8	63	13	7
Average and total	65.0	18.04	.....	.....	60	30	22
August	68.0	.60	285.8	429.4	67	15	5
September	62.2	6.50	186.4	374.5	50	10	12
October	52.4	1.54	177.5	342.5	52	10	11
Average and total	60.9	8.64	.....	.....	56	35	28
General average and sum total	63.0	26.68	.....	.....	58	65	50

The precipitation for the early growing months of May, June, and July was excessive, especially for the two months last named. Dur-

ing the second period of three months the August precipitation was deficient and the September rainfall was excessive, while October was somewhat dry and favorable to securing the maturity of the plants. It is evident that had two-thirds of the September rain fallen in August there would have been a larger yield of beets and perhaps of a better quality. Both the percentage of sugar in the beet and the purity of the juice, however, are very satisfactory.

THE NEW YORK STATION AT GENEVA.

The following cultural data are reported by the Geneva station:

The seed was sown on May 30, 1902. The ground was plowed and subsoiled in the spring to the depth of 14 to 16 inches. The fertilizer intended for the work was mixed and weighed out, but the fire of May 7 destroyed it and before a new supply could be obtained it was too late, and therefore no fertilizer was used.

On June 4 the seed began to vegetate and growth went on rapidly. A very uniform stand was obtained without reseeding. On June 14 the beets were cultivated by hand, and three subsequent cultivations with a one-horse cultivator were given. Thinning was begun on June 27 and finished on June 30. The beets were thinned to approximately 8 inches in the rows, the rows being 20 inches apart. The beets were practically free from leaf spot and grew with vigor throughout the season. The data on the beets determined at the New York station are as follows, each sample representing 50 beets.

Agricultural and analytical data determined at Geneva, N. Y.

Date harvested.	Average weight.	Yield per acre.	Sugar in juice.	Sugar in beet.	Purity coefficient.
1902.	*Ounces.*	*Tons.*	*Per cent.*	*Per cent.*	
October 14	13.8	.....	17.1	14.9	91.9
November 13	17.5	16.06	17.1	14.3	87.4
Average	15.7	16.06	17.1	14.6	89.7

The data determined at Washington, D. C., on the beets forwarded from Geneva are shown in the following table:

Agricultural and analytical data on beets grown at Geneva, N. Y.

Date received.	Average weight after topping.	Estimated yield per acre.	Sugar in juice.	Sugar in beet.	Purity.
1902.	*Ounces.*	*Tons.*	*Per cent.*	*Per cent.*	
September 22	10.6	.....	15.1	13.9	83.9
September 30	13.1	.....	15.7	14.4	84.4
October 9	14.4	.....	14.1	12.9	83.9
October 14	17.4	.....	14.1	12.9	83.4
October 21	14.7	.....	15.1	13.9	86.3
October 29	14.7	.....	15.3	14.1	85.5
November 4	12.5	.....	15.9	14.6	85.0
November 11	17.6	.....	15.6	14.4	84.3
November 18	13.7	.....	15.3	14.1	84.1
Average	14.3	[a]16.1	15.1	13.9	84.5

[a] Estimate made at Geneva.

Unfortunately only very scanty meteorological records are procurable for this locality, the temperature and precipitation record kept at the voluntary station at Lyons, 13 miles north of Geneva, furnishing the only data available except rainfall reported from Geneva in the following paragraph.

Meteorological data for Lyons, N. Y.

Month.	Mean temperature.	Precipitation.
1902.	°F.	*Inches.*
May	58.8	3.03
June	64.0	3.39
July	72.4	6.77
Average and total	65.1	13.19
August	67.8	2.22
September	64.4	2.57
October	51.0	2.79
Average and total	61.1	7.58
General average and sum total	63.1	20.77

The following comments on the season are made in the station report on the experiment:

The season was an unusual one in some respects. Periods of excessive moisture were followed by drought, making it difficult to give the crop frequent cultivation. The rainfall as observed at Geneva for the growing season was as follows:

	Inches.		Inches.
June	4.33	October	2.32
July	5.25		
August	2.41	Total	17.19
September	2.88		

In June the longest period without rain was three days. From July 9 to 15 was dry. In August the longest period with no rain was five days, from August 12 to 17. In September there was but 0.75 inch from the 1st to the 22d. The coldest October and the warmest November were experienced that have been known in this latitude for twenty years.

The analytical data determined at the Geneva station and those obtained at Washington vary somewhat, the Geneva figures for purity and sugar in the beet being higher. Only two samples, however, were examined at Geneva, and those were of the perfectly matured beets, the samples having been taken on October 14 and November 13, while the samples received at Washington covered a range of harvesting from the last of September to the middle of November. The difference in the percentages of sugar in the beets as obtained at the two stations is only 0.7 per cent, while the difference in the purity coefficients is 5.2 per cent. Following the usual rule, the data obtained in this laboratory have been platted in preference to those of the collaborating station. This is not done because of any assumed greater degree of accuracy, but because the analyses made here are all per-

formed under standard and uniform conditions. In point of fact there may possibly be some slight deterioration in the samples sent to Washington, especially those coming a long distance. This deterioration can never be very great, however, if the directions for packing and shipping are followed carefully.

THE NEW YORK STATION AT ITHACA.

The following report on the beet work as conducted at the Ithaca station was made by Mr. J. L. Stone, assistant in agriculture, under date of December 4, 1902:

The sugar-beet seed No. 8238 of the Department of Agriculture was planted May 13, 1902, at the extreme southwest corner of the permanent series of plats. * * * The land was plowed early and harrowed at intervals till the time of planting. Seed was sown with a hand drill, the distance between the rows being 22 inches. The dates of cultivation seem not to have been recorded, but the crop was well cared for, no weeds being observed when the plats came into the writer's care in September. The plants were thinned to a stand on June 19. When harvesting began on September 18 the beets were immature, and the soil had been very wet most of the time since early June. The last days of September were bright and sunny. October was nearly normal as regards precipitation, but the soil was still quite wet from earlier rains. November, up to the 25th of the month, was unusually warm, with little rainfall. Second growth had taken place to a considerable extent. * * * The following are the dates of harvesting and data relating to the same:

Agricultural data determined at Ithaca.

Date of harvest.	Number of beets in 50 feet.	Total weight with crowns.	Weight of 25 beets.	Dockage.	Estimated yield per acre (trimmed).
1902.		*Pounds.*	*Pounds.*	*Per cent.*	*Tons.*
September 18	67	68.0	25.0	10.4	14.47
September 25	66	70.0	26.0	12.5	14.55
October 2	62	82.0	35.0	8.5	17.83
October 9	64	82.0	33.0	8.5	18.24
October 17	71	87.0	34.5	10.0	18.61
October 25	60	91.5	37.0	9.3	19.72
November 1	63	85.5	33.5	10.5	18.18
November 10	58	79.5	35.0	9.0	17.19
November 17	63	94.5	37.0	8.7	20.75
November 25	60	102.5	45.0	14.0	20.94
Average	63	84.3	34.1	10.1	18.05

Evidently the per cent of dockage was materially increased at the last date owing to the second growth and the consequent increase in the weight of the crown. However, it is evident that at different dates of harvest the manner of trimming the beets was not quite uniform or the per cent of dockage would not vary so irregularly.

The following tables show the data determined at Washington on the beets shipped from the Ithaca station, and also the climatic conditions under which they were grown:

Agricultural and analytical data on beets grown at Ithaca, N. Y.

Date received.	Average weight after topping.	Estimated yield per acre	Sugar in juice.	Sugar in beet.	Purity coefficient.
1902.	*Ounces.*	*Tons.*	*Per cent.*	*Per cent.*	
September 22	13.1	10.9	13.1	12.1	81.9
September 30	13.8	10.9	12.9	11.9	82.7
October 7	17.3	14.1	11.7	10.8	79.1
October 14	16.6	20.1	12.1	13.9	79.6
October 21	17.9	20.5	13.2	11.1	81.5
October 29	19.8	21.4	14.0	12.9	83.8
November 7	16.6	20.0	14.2	13.1	85.0
November 14	17.6	19.2	14.3	13.1	85.6
November 22	16.0	19.9	14.4	13.2	82.7
November 29	21.6	23.0	13.6	12.6	76.8
Average	17.03	18.0	13.3	12.5	81.87

Meteorological data for Ithaca, N. Y.

Month.	Mean temperature.	Precipitation.	Clear days.	Cloudy days.
1902.	° *F.*	*Inches.*		
May	54.5	2.05	8	10
June	62.2	5.39	4	5
July	69.8	6.69	6	10
Average and total	62.2	14.13	18	25
August	65.6	3.13	9	6
September	61.1	2.70	11	8
October	49.2	3.36	3	15
Average and total	58.6	9.19	23	29
General average and sum total	60.4	23.32	41	54

The agricultural data from the Ithaca station are very full and satisfactory, but no chemical analyses of the samples were made at the station. The results of our analyses show, as in previous years, that the beets grown at the Ithaca station are slightly inferior to those produced at the Geneva station, although the difference of location of the two stations is not very great. A comparison of the climatic conditions existing at the two stations is not directly possible, because practically no data are given for Geneva itself. In comparing the meteorological data given for Lyons, 13 miles from Geneva, with the Ithaca report, we find that the temperature at Ithaca is lower than at Lyons, which would be contrary to the general rule that the lower temperature favors the production of a richer beet.

THE VIRGINIA STATION.

Details in regard to the sugar-beet experiment at the Blacksburg station were reported by Mr. Alwood, under date of September 13, 1902, as follows:

The land chosen for the plat this year is a fairly strong clay loam which had been farmed in corn the two previous years and heavily cropped, using some phosphate;

how much I can not say positively. This land came to the garden department last fall. We covered it very heavily with manure and plowed it in the late fall, and it was left rough all winter. This spring before planting we harrowed the land severa times and then on April 30 replowed and subsoiled it down to 18 inches. The land was put in fine tilth before planting. There was so much manure in the soil that the soil samples were not taken at that time. * * * On May 1 the plat was sown with seed No. 8238, using a garden drill, and placing the rows about 18 inches apart. The seed was sown thickly in the row. The season turned exceedingly dry from May 1 and has so continued up to this date, yet the fine condition of the land has enabled us to grow a very fair crop.

Vegetation occurred in one week, and for several weeks the land was cultivated with a hand tool, giving a shallow cultivation once each week, and the beets were thinned as directed in the instructions. By June 30 the growth of tops was so luxuriant that the ground was practically hidden from view. On September 1 the outer leaves began to fall down and rest on the surface of the soil. On this date 50 feet of row was sampled, with the following results:

Number of beets in 50 feet of row		72
Weight of beets, leaves removed only	pounds	76
Weight of 25 beets not topped	do	31⅝

Under date of September 19 the following additional report was made:

I sent you yesterday the second sample of beets, and the data concerning the same are as follows:

Fifty feet of row in this case dug only 57 beets. It happened that this section of row had a number of vacant spots. I have already mentioned that the drought was very severe here at the time of planting. This number of beets weighed, after taking off the leaves, 60 pounds. The weight of the 25 beets sent to you was 27¾ pounds.

There was a very heavy frost here last Sunday morning, and a somewhat slighter frost occurred Monday morning [September 14 and 15]. The result is that the tops of the beets are now much fallen over, though they are not blackened nor killed, but I think the crop is practically at full maturity, or at least will be next week.

The data obtained on the samples of these beets shipped to Washington from the Blacksburg station are given in the following table:

Agricultural and analytical data on beets grown at Blacksburg, Va.

Date received.	Average weight after topping.	Estimated yield per acre.	Sugar in juice.	Sugar in beet.	Purity coefficient.
1902.	*Ounces.*	*Tons.*	*Per cent.*	*Per cent.*	
September 16	16.0	.....	12.0	11.0	71.4
September 20	13.8	.....	13.3	12.2	78.7
September 27	16.6	.....	12.8	11.8	73.6
October 9	15.0	.....	12.9	11.9	73.7
Total	15.4	[a]16.7	12.8	11.7	74.4

[a] Approximate estimate made on data given in reports of September 1 and 19.

The meteorological data reported for Blacksburg are as follows:

Meteorological data for Blacksburg, Va.

Month.	Mean temperature.	Precipitation.	Clear days.	Cloudy days.
1902.	° *F.*	*Inches.*		
May	63.9	1.85	20	2
June	68.4	2.90	10	8
July	72.5	4.09	10	6
Average and total	68.3	8.84	40	16
August	71.3	1.06	9	8
September	63.2	2.22	13	9
October	55.1	3.06	12	13
Average and total	63.2	6.34	34	30
General average and sum total	65.8	15.18	74	46

Although Blacksburg is considerably south of both Washington and Lexington, the mean temperature for the six months of the growing season is 2.8° less than at Washington and 3.5° lower than at Lexington. The low latitude of course produces a shorter length of day for the growing season, so that the hours of sunlight at Blacksburg are fewer than at Washington or Lexington. Nevertheless the low temperature occasioned by the great altitude is reasonably favorable to the production of beets with a high content of sugar. The purity of the juices, however, is far below the standard for beets of a richness of almost 12 per cent. The yield per acre is fairly satisfactory.

THE WISCONSIN STATION.

A detailed and very interesting report on the sugar-beet experiment, as conducted at Madison, was made by Mr. F. W. Woll, station chemist, and Mr. R. A. Moore, agriculturist. The report is given practically in full, as follows:

The land on the university farm devoted to sugar beets during the past season was about two-fifths of an acre in area. The soil is a clay loam with a heavy clay subsoil and has a decided tendency to bake after rains, a thick, solid crust being then formed on the surface. During the frequent heavy rains in June and July the soil became quite hard and compact, and the effect of this was seen in the shape of the beets harvested, many of them being forked and abnormally thick and short.

The field, which lies in the western portion of the experimental plat grounds, was divided into 7 plats of one-twentieth of an acre each. Cereal and rape crops were grown on plats Nos. 1 to 5 during the two previous seasons, while the two plats farthest north (Nos. 6 and 7) were in clover during these years. The field was in a high state of fertility. A medium application of barnyard manure was put on plats Nos. 1 to 5 in the fall of 1901 previous to plowing, while plats Nos. 6 and 7 were plowed about 6 inches deep in the spring of 1902. In addition to barnyard manure three of the plats received the following artificial fertilizers: Plat No. 4, 50 pounds of Armour's Sugar-Beet Grower, 29 pounds of nitrate of soda, and 20 pounds of sulphate of potash. The commercial fertilizers were harrowed in directly before plant-

ing, except in case of the nitrate, of which one-half was applied at planting time and the remainder when the beets were thinned.

The beet field was disked and harrowed on April 15, and again on April 24, when the seed bed was carefully prepared and the seed planted in rows 18 inches apart, at the rate of 20 pounds to the acre. The field was harrowed lightly after the seed was put in. It was cultivated with a hand cultivator on May 8, 19, 22, and June 3. The beets were hand-hoed on May 22 and June 20, and thinned on May 26, so that the plants stood approximately 9 inches apart in the row. The field did not receive any further treatment after June 20 until harvesting time, except that all weeds were pulled by hand on July 21. The stand of the beets was perfect and the field presented a fine appearance, the beets looking thrifty and strong throughout the growing period.

Owing to the abundance of moisture during the summer months and the cool weather during August and September the beets matured later than is usually the case in this locality. Samples of the beets grown on plat No. 4 were taken every week from September 14 to October 11, as requested by the Bureau of Chemistry, United States Department of Agriculture. The beets in 50 feet of row were dug and weighed before and after being washed, 3 beets of average size being taken in each case for a sample. The results of the weighings and analyses made on the different dates of sampling, as obtained at this station, are shown in the following table:

Agricultural and analytical data determined at Madison, Wis.

Date of sampling.	Average weight.		Estimated yield per acre (washed).	Sugar in juice.	Sugar in beet.	Purity coefficient.
	Beets as dug; topped at crown.	Washed; topped below leaf buds.				
1902.	*Pounds.*	*Pounds.*	*Tons.*	*Per cent.*	*Per cent.*	
September 14	1.5	1.03	30.0	14.4	13.3	78.6
September 20	1.6	1.17	27.3	14.3	13.2	79.3
September 27	1.8	1.58	34.8	14.0	12.9	83.3
October 4	1.8	1.58	33.1	15.7	14.4	81.0
October 11	.....	1.26	29.7	13.8	12.7	77.4
Average	1.7	1.32	31.0	14.4	13.3	79.9

Single analyses do not always give a correct indication of the maturity of the beets at the time of sampling, and the results, therefore, should not be interpreted too strictly. But slight improvement occurred in the sugar content or purity of the beets after the first sampling, as far as could be observed.

The following table shows the data obtained at the Bureau of Chemistry for the samples shipped from the Madison station on the dates of sampling given in the preceding table:

Agricultural and analytical data on beets grown at Madison, Wis., as determined at Washington, D. C.

Date received.	Average weight after topping.	Estimated yield per acre.	Sugar in juice.	Sugar in beet.	Purity coefficient.
1902.	*Ounces.*	*Tons.*	*Per cent.*	*Per cent.*	
September 17	17.8	.....	13.6	12.5	82.4
September 30	20.2	27.3	14.0	12.9	80.5
October 1	16.3	35.0	14.5	13.3	84.8
October 9	25 9	33.0	13.0	12.0	79.3
October 21	40.6	.....	13.9	12.8	83.2
Average	24.2	31.8	13.8	12.7	82.0

The report of the Wisconsin station continues as follows:

Usually beets grown in this locality are ready for harvesting during the first half of the month of September. The beets this year, however, were not harvested until October 11. Those grown on the different plats were of course kept separate, while those grown in the spaces between the plats were thrown together and sampled separately, the data for these beets being given under plat No. 8 in the following table:

Agricultural and analytical data determined at Madison at the time of harvest.

Plat No.	Average weight.	Yield per plat.[a]	Yield per acre.	Sugar per acre.	Sugar in juice.	Sugar in beet.	Purity coefficient.
	Pounds.	*Pounds.*	*Tons.*	*Pounds.*	*Per cent.*	*Per cent.*	
1	1.34	3,196	32.0	8,371	14.22	13.08	85.2
2	1.42	3,042	30.4	8,637	15.49	14.25	82.6
3	1.27	3,115	31.2	8,811	15.37	14.14	87.3
4	1.26	2,974	29.7	7,489	13.77	12.67	81.0
5	1.44	3,054	30.5	8,333	14.85	13.66	83.1
6	1.42	2,814	28.1	7,789	15.06	13.86	85.1
7[b]	1.46	2,755	27.6	7,529	14.83	13.64	88.4
8	1.12	2,533	29.9	8,647	15.72	14.46	85.0
Total and average	1.34	23,483	29.9	8,213	14.91	13.72	84.5

[a] Each plat about one-twentieth of an acre.
[b] Beets taken from spaces between plats.

The most striking feature of the results presented in the preceding table is the large tonnage. More than 11 tons of washed beets were harvested from an area of only about two-fifths of an acre, which represents a yield of nearly 30 tons per acre. This is an extraordinary tonnage, which has never been equaled in previous trials with sugar beets at this station. The following summary shows the average yields of sugar beets obtained at the university farm during the past twelve years:

Average annual yield of sugar-beet crop for twelve years.

Season.	Yield per acre.	Sugar per acre.	Season.	Yield per acre.	Sugar per acre.
	Tons.	*Pounds.*		*Tons.*	*Pounds.*
1890	19.80	5,913	1900	16.99	3,862
1891	7.34	2,267	1901	10.97	2,623
1892	11.31	3,821	1902	29.94	8,213
1897	9.13	2,503			
1898	18.71	5,312	Average	15.89	4,258
1899	18.83	5,805			

The unusually large tonnage of 1902 is no doubt to be attributed to the following three causes: The abundant supply of moisture during the growing season; the high state of fertility of the soil on which the seed was planted; and the long vegetation period which obtained, the seeds having been planted and the beets thinned nearly one month earlier than had been the practice in previous years. While the beet field was not large there would have been no difficulty in securing a yield of the same proportions for a larger area had there been a sufficient force at the University farm to cultivate it.

The expense of growing an acre of beets under ordinary conditions is generally estimated to be from $25 to $30. Beets of the quality of those grown at the University farm during the past season are paid for at the sugar factory at Menomonee Falls, Wis., at the rate of $4.42 per ton. This would make the product from an acre worth $132.60, a net profit of upward of $100 per acre. The expense of the labor required to keep the field free from weeds was higher this year than in ordinary seasons on account of the difficulty in getting to the field at the right time after the many heavy rainstorms during the early part of the summer. The profit of growing

an acre of beets with a yield like that secured during the past season would at all events be very large. The results of investigations conducted at this station in the past have shown that even if the yield of beets should be only one-half of that obtained this year the beet crop would still be a very profitable one for Wisconsin farmers to engage in if they are within a reasonable distance of a beet factory. Estimating the value of the beets and the cost of growing them as above, there would still be a net profit on a crop of half the size of that of 1902 of about $40 per acre of beets grown. It is believed that there are few crops that can be grown in this State which will pay better during a series of years than sugar beets, provided proper attention is given to the crop. As one sugar factory has been in operation in this State for two seasons, and one or two more will in all probability be erected in time for next season's crop the farmers in many localities in our State will soon have an opportunity to engage in the growing of sugar beets for factory purposes. The practical importance of the subject to the farmers of Wisconsin is therefore evident.

In the following table are given the climatic data available for Madison. Mr. Shaw, in commenting on the season, said that the excessive rains of July, followed by almost continuous cloudy weather, while unfavorable for cereal crops, was very favorable to the growth of green forage and root crops, of which large yields were harvested.

Meteorological data for Madison, Wis.

Month.	Mean temperature.	Precipitation.	Clear days.	Cloudy days.
1902.	°F.	*Inches.*		
May	59.8	5.16	3	17
June	63.2	4.27	3	18
July	71.3	8.98	4	13
Average and total	64.8	18.41	10	48
August	66.8	.78	11	7
September	58.2	4.18	8	13
October	51.4	1.23	9	8
Average and total	58.8	6.19	28	28
General average and total	61.8	24.60	38	76

The agricultural data obtained from the Wisconsin station are particularly satisfactory in their fullness and detail. The yield per acre, as estimated from the harvested areas, is extremely high. The average weight of the beets is particularly satisfactory, and it is only with beets of this average weight that such high yields can be obtained. In the samples harvested on October 21 and sent to this Bureau the average weight of the beets was phenomenally high, and yet there was no decrease either in the percentage of sugar in the beet or in the purity; in fact, this sample, both in respect of the sugar in the beet and purity, was above the average of the other samples. There is a slight discrepancy between the analytical data obtained at Madison and at this Bureau, in that the figures obtained at Washington for the content of sugar and purity are somewhat lower. The high yield may be attributed to a naturally fertile soil, well prepared, judicious fertilization, timely culture, and a favorable amount and distribution of

rainfall. During the first growing period of three months the rainfall was probably excessive, and especially was this true of the month of July. August, as at most of the stations, was a dry month, and September somewhat too wet. October was favorable for ripening and harvesting. The mean temperature was low, thus favoring a high sugar production. The record for this year, upon the whole, must be regarded as extremely satisfactory, and may well be taken as a model for work of this kind.

EXPERIMENTS CONDUCTED IN IRRIGATED SECTIONS.

THE CALIFORNIA STATIONS.

A very complete and interesting report was received from G. W. Shaw, of the California station, in regard to the sugar-beet experiment as conducted at that point. The report is here given practically in full:

The cooperative experiment with sugar beets was conducted under the supervision of the writer at the Pomona substation grounds and on the 10-acre tract at Chino. These localities are but a few miles apart, and their climatic conditions are the same, the only difference in the two localities being in the character of the soil, and in the fact that at Pomona the beets were grown under irrigation and at Chino without irrigation. The soil was prepared by a deep spring plowing, and worked to a fine tilth. The seed was planted on April 2, in drills 20 inches apart, the entire plat being 160 by 75 feet.

POMONA (IRRIGATED).

The seeds were slow to germinate, and on April 14, the beets on the Pomona tract were irrigated to hasten germination. To secure a uniform stand beets were transplanted to fill vacant spaces in the rows on May 5, and again on May 14, and the plat was thinned from May 6 to 8.

Including the early irrigation mentioned above, the beets received the following-named quantity of water on the dates given:

Irrigation data, Pomona, Cal.

Date of irrigation.	Amount of water remaining on plat.		
1902.	*Gallons.*	*Cubic feet.*	*Acre inches.*
April 14	12,500	1,763	.....
May 20	5,000	669	.....
June 17	14,000	1,875	.....
July 15	8,750	1,172	.....
July 22	8,575	1,172	.....
July 29	8,575	1,172	.....
August 5	8,575	1,172	.....
Total	65,974	7,823	8.82

The above figures represent the actual amount of water remaining on the plat, as the wastage was estimated as exactly as possible and subtracted from the amount applied. In addition to the 8.82 acre-inches of water received by irrigation, the soil had the benefit of the following natural rainfall during the year:

	Inches.
October, 1901	2.29
November	.67
January, 1902	1.92
February	3.35
March	3.85
April	.25
May	.10
Total by rainfall	12.43
Total by irrigation	8.82
Total water	21.25

Of this total amount, 9.17 inches were applied after planting. It should be stated that the soil is not one retentive of moisture, and except for irrigation would not produce a crop requiring as much moisture as sugar beets, although the season in this locality in other particulars would be considered as favorable for the crop. The analytical and field data on the crop of 1902 are as follows:

Agricultural and analytical data determined at Pomona, Cal.

Date harvested.	Yield per acre.	Sugar in juice.	Sugar in beet.	Purity coefficient.
1902.	*Tons.*	*Per cent.*	*Per cent.*	
September 26		18.7		83.8
October 4		17.8	15.48	85.6
October 11		15.5		91.0
October 18		15.3	14.60	84.5
October 25		15.8	15.00	87.7
November 1		15.1		87.4
November 8		16.8		85.5
Average	5.0	16.4	15.02	86.5

It will be noted that the beets sampled first had the highest percentage of sugar, and it may be that an earlier sampling would have shown even a higher sugar content. During the period of sampling the beets lost about 3 per cent in sugar, but gained that much in purity; hence the actual sugar content remained about the same. There was, however, no decided increase in tonnage. The planting of the beets was decidedly too late for this coast, producing a disastrous effect on the yield, which was but a trifle over 5 tons per acre. The poor quality of the soil also influenced the low yield to a great extent.

The factor showing the relation of sugar in the beet to sugar in the juice, as determined by the hot aqueous method, was 91.6, which my experience leads me to believe to be much nearer the truth for beets in the Western States than the time-honored one of 95 so commonly used and accepted as correct.

CHINO (ALKALI SOIL, NOT IRRIGATED).

The results obtained on the 10-acre alkali tract at Chino are shown in the following table:

Agricultural and analytical data determined at Chino, Cal.

Date harvested.	Estimated yield per acre.	Sugar in juice.	Purity coefficient.
1902.	*Tons.*	*Per cent.*	
September 26	7.40	17.00	87.2
October 4	5.46	17.65	89.6
October 11	13.85	14.70	87.5
October 18	15.71	16.30	89.5
November 1	8.65	13.70	87.7
November 8	9.58	13.10	85.6
December 2	11.71	14.42	88.8
Average	10.34	15.27	88.1

The results on this land are clearly favorable, and show that beets of high quality can be produced upon soil containing at least 5,480 pounds of alkali per acre-foot, and other experiments show that this amount may be exceeded provided the percentage of chlorids and carbonates does not rise too high.

It is noticeable that the beets grown on this tract also fell off materially in sugar content after October 1. This was not due in either case to rainfall nor to irrigation, since from May until November 24 there was no rain, and irrigation was discontinued on August 5 at Pomona. Just why there should be this sudden decrease in sugar is not clear; the fact, however, is quite striking in both cases. The average factor showing the relation between the sugar in the beet and the sugar in the juice for this plat was 93.1.

The meteorological data furnished by the voluntary station near Pomona, considered in connection with those from the Los Angeles station, about 15 miles west of the Pomona and Chino experiment grounds, give a complete record of the climatic conditions for the growing season.

Meteorological data for (near) Pomona, Cal.

Month.	Mean temperature.	Precipitation.	Sunshine.			Clear days.	Cloudy days.
			Actual.	Possible.	Per cent.		
1902.	°*F.*	*Inches.*	*Hours.*	*Hours.*			
May	64.1	0.10				13	2
June	72.5	.23				11	0
July	74.0	.00				6	0
Average and total	70.2	.33				30	2
August	73.8	.00				8	0
September	72.8	.00				11	0
October	62.6	.26				18	4
Average and total	69.7	.26				37	4
General average and sum total	70.0	.59				67	6

Meteorological data for Los Angeles, Cal.

Month.	Mean temperature.	Precipitation.	Sunshine,			Clear days.	Cloudy days.
			Actual.	Possible.	Per cent.		
1902.	° *F.*	*Inches.*	*Hours.*	*Hours.*			
May	60.7	0.03	318.8	432.6	74.0	8	1
June	66.4	Tr.	295.4	431.5	68.0	10	1
July	68.4	Tr.	268.7	439.7	61.0	9	3
Average and total	65.2	.03	.....	.....	67.7	27	5
August	69.1	Tr.	314.0	415.8	76.0	12	0
September	69.2	Tr.	275.2	371.8	74.0	11	1
October	63.2	.40	236.0	350.9	67.0	11	6
Average and total	67.2	.40	.....	.....	72.3	34	7
General average and sum total	66.2	.43	.....	.....	70.0	61	12

The work inaugurated with irrigation stations marks the beginning of the study of a new consideration as affecting the activity of different factors of the environment upon the composition of the crop. In the reports from the California stations just given we find an illustration of what has been well demonstrated regarding the ability of irrigated lands to produce crops of sugar beets phenomenally rich in sugar. At the Pomona station the yield per acre is not satisfactory, although with such rich beets as were there raised the farmer could secure a satisfactory monetary return for the crop produced. The yield was not quite one-half as large as that produced on the Chino plat which was not irrigated. This is evidently a case in which a judicious intensive fertilization would very largely increase the yield without diminishing to any notable extent the percentage of sugar or the purity of the juice, and would, therefore, be highly profitable.

In regard to the meteorological data the principal points to be considered are that, although the mean temperature for the six growing months is higher than at Washington, there were no periods of intense heat; June, July, August, and September had almost an even temperature. At Los Angeles there was also an even temperature, September being the warmest month. The general average for the six months was 3.8° lower than at Pomona. The rainfall at both stations was so small as to be negligible. The high percentage of sunshine is of course to be expected under such meteorological conditions as obtained at the California stations mentioned. It is evident that continuous sunshine, where the temperature does not run too high, is not injurious in any way to the functional activity of the chlorophyll cells. Where sufficient moisture is supplied by irrigation and a proper quantity of suitable plant foods exists, the other conditions combine to make such regions almost ideal for beet culture.

THE COLORADO STATION.

As several sugar-beet experiments were conducted at the Colorado station in 1902, it has been impossible to separate all mention of the other work from that carried on with seed No. 8238 of this Bureau, especially since all the beet plats received the same treatment and were planted at the same time, each plat being, however, clearly distinguished from the others. The following extracts from the general report made by A. H. Danielson, agronomist of the Colorado station, give the details of the conduct of the experiment at Fort Collins:

The soil this season had been plowed, harrowed, and leveled with a drag until it was in the best possible condition. As a result of the rain and snow storm on April 14 there was plenty of moisture in the soil to insure the germination of the seed. The ground was leveled twice just before drilling in the beet seed, stirring the soil in such a thorough manner as to give the beets an equal chance with the weeds. If anything, the soil was a little too loose and mellow.

One plat of variety No. 8238 was planted on April 17 near the edge of the field where the soil was not in the best possible condition on account of the tramping of the animals in working the soil. However, this condition seemed to affect the three or four outside rows only. To insure an equal comparison between the various stocks of beets this variety was again planted next day near the center of the field. All other varieties were planted on April 18, in rows east and west 20 inches apart and to an average depth of three-fourths to 1½ inches, with a regulation "shoe" beet drill with the press wheels on, set about three-fourths of an inch apart, so that the soil was not compacted immediately over the seed, but only on each side of the row. There was planted just two drill widths of each variety or stock, making eight rows of each.

Seed was planted at the rate of about 22 pounds per acre, the idea being to plant enough seed to make a full stand of beets. The beet seed evidently appreciated the good treatment it had received; for on the ninth day a few were coming up, and on April 28 the young plants were just breaking the crust. On May 2 every row was showing distinctly, with no difference whatever in the rate of germination between the various stocks of seed.

Thinning the beets to a distance of 8 inches apart was begun on May 29, and finished on June 6. At the beginning the young plants had an average of 7 leaves to a plant and at the last the beets had increased to an average of 12 leaves to the plant.

When the beets had attained some size cultivation was begun, the first being given on May 22 with the beet cultivator. As a rule after the beets had become of some size a furrow was made between the rows at the time of cultivating to allow of irrigation later. The water used in irrigating was not measured, but from previous experience a close estimate is believed to be about 0.3 or 0.4 foot over the ground at each period. The water was allowed to flow between the rows until the soil was thoroughly saturated.

The following notes were made in the field at the time:

May 22.—Cultivated with beet cultivator for the first time.

May 24.—The young plants are growing very rapidly, but some roots show an attack of a fungous disease like "damping off." The roots of some of the young plants are dead and shriveled and others partly decayed. It is believed this disease may be due to the fungous disease "rhizotonia," which pervades our soils in this locality.

June 10.—Cultivated and furrowed for irrigation.

June 12.—Irrigating the beets; the water ran in the furrows an average of twelve hours each; some furrows had water as long as forty-eight hours. The beets are doing well and look exceedingly thrifty. A fine stand, none missing. An inspector from a sugar factory said it was the best stand on a small area in the neighborhood.

June 18.—Cultivated.
June 19.—Weeds hoed out and ground cleaned by hand.
June 27.—The beets are exceedingly thrifty, almost covering the ground; hardly a weed in evidence.
July 24.—Cultivated and furrowed for irrigation at the same time. The soil is very moist from recent rains.
July 26, 27, 28.—Irrigated thoroughly with small head of water. Water is very scarce just now. This is the last irrigation the beets can receive.
July 31.—Weeded by hand.

On September 12 an early frost damaged the leaves to such an extent that the selection of beets for mother beets, from the character of the leaves, was suspended for a time. The leaves began to grow again in a few days, and in a couple of weeks an entire new crop of leaves was out, when the selection was continued. The recovery of growth was helped greatly by the downpour of rain on September 20–21, amounting to nearly 6 inches. It was feared at first that this heavy rain would retard the ripening of the beets or lessen the sugar content considerably. That this did not take place to any great extent is shown by the analysis of samples of these beets taken from one of the plats during the harvesting season and analyzed at the Bureau of Chemistry. The results obtained on all the samples sent to Washington for examination are shown in the following table:

Agricultural and analytical data on beets grown at Fort Collins, Colo.

Date received.	Average weight after topping.	Estimated yield per acre.	Sugar in juice.	Sugar in beet.	Purity.
1902.	*Ounces.*	*Tons.*	*Per cent.*	*Per cent.*	
September 24	18.2	20.2	14.0	12.9	80.5
October 7	18.3	26.0	13.1	12.1	78.3
October 9	19.8	.....	11.4	10.5	74.0
October 21	22.4	.....	10.6	9.8	66.6
October 28	16.5	20.2	14.4	13.2	81.4
November 1	21.4	.....	15.5	14.3	83.8
November 11	21.4	31.7	15.1	13.9	80.4
November 14	19.5	24.3	16.0	14.7	87.0
November 22	15.2	28.1	15.6	14.4	84.3
November 29	19.5	28.5	14.9	13.7	78.0
December 6	20.9	26.7	14.8	13.6	79.1
December 13	23.3	20.7	14.1	13.0	79.7
Average	19.7	24.0	14.1	13.0	79.4

The general yield of sugar beets in northern Colorado this season was not as satisfactory as it might have been, the average yield being nearly 9 tons per acre. A close study and measurement of this field showed that the stand of beets could have been at least 10 per cent better, there being one beet out of every ten missing, or an open space in which a beet should have been growing. This was general over the field and not confined to any one variety.

The meteorological conditions under which these beets were grown are given in detail below, Cheyenne, Wyo., 40 miles northeast of Fort Collins, being the nearest station at which the sunshine data were available. In general the weather was too dry for beets. At the beginning of the ripening season, however, the event most worthy of note was the heavy September rain and the general wet weather prevailing for some weeks thereafter.

Meteorological data for Fort Collins, Colo.

Month.	Mean temperature.	Precipitation.	Sunshine.			Clear days.	Cloudy days.
			Actual.	Possible.	Per cent.		
1902.	°F.	*Inches.*	*Hours.*	*Hours.*			
May	56.1	2.13					
June	63.6	2.43					
July	66.0	1.31					
Average and total	61.9	5.87					
August	68.7	.67					
September	56.8	7.12					
October	48.8	1.15				15	8
Average and total	58.1	8.94				49	17
General average and sum total	60.0	14.81				94	32

Meteorological data for Cheyenne, Wyo.

Month.	Mean temperature.	Precipitation.	Sunshine.			Clear days.	Cloudy days.
			Actual.	Possible.	Per cent.		
1902.	°F.	*Inches.*	*Hours.*	*Hours.*			
May	52.8	2.51	245.9	449.1	55.0	7	12
June	61.0	1.55	266.3	451.9	59.0	7	12
July	63.8	1.49	295.2	458.6	64.0	10	7
Average and total	59.2	5.55			59.3	24	31
August	67.0	0.53	261.0	427.4	61.0	9	7
September	54.0	3.52	273.9	374.0	73.0	14	6
October	47.8	0.52	218.2	343.9	63.0	11	10
Average and total	56.3	4.57			65.7	34	23
General average and sum total	57.8	10.12			62.5	58	54

In the data from Colorado we have a remarkable contribution to the study of the effect of environment upon composition. The total rainfall for the six growing months was 14.81 inches, only 2 or 3 inches below the average precipitation for the nonirrigated stations. The distribution, however, was somewhat unfavorable, as nearly one-half the total quantity fell during the month of September. During the dry months the deficiency in rainfall was corrected by irrigation. The temperatures were low compared with those of the other irrigated areas, the average for the six months being only 60°. There was a large percentage of clear days, and it is evident that the beets received an abundance of direct sunshine.

The yield per acre was very heavy, being nearly five times that obtained at the Pomona, Cal., station, and two and a half times that of the nonirrigated station at Chino. The percentage of sugar in the beet is reasonably satisfactory, but the purity is somewhat too low. It is stated in the report of Mr. Danielson that in richness the beets in northern Colorado were not up to the standard of previous years. With the large yields obtained, however, the yield of sugar must be regarded as highly satisfactory.

THE UTAH STATION.

The following cultural and analytical data have been reported by Director Widtsoe of the Utah station:

The beet plat was one-twentieth of an acre in area. Barnyard manure was applied at the rate of 20 tons per acre during the winter of 1901–02. The plat was plowed 10 inches deep and subsoiled 8 inches deeper on May 12, 1902. It was harrowed immediately afterwards and seeded on May 14, at the rate of 15 pounds of seed per acre, the rows being 20 inches apart. The beets were thinned and cultivated on June 14, and were irrigated on June 11 and on August 14, being cultivated two days after each irrigation. On August 2 the crop was reported to be looking well, with a medium stand, and tops 14 inches high. The irrigation water was not accurately measured, but was not far from 7 inches in depth over the whole plat at each irrigation.

Agricultural and analytical data determined at Logan, Utah.

Date of harvest.	Average weight of beets.	Yield per acre.[a]	Sugar in juice.	Sugar in beet.[b]	Purity coefficient.
1902.	*Ounces.*	*Tons.*	*Per cent.*	*Per cent.*	
September 25	11.48	13.8	15.01	13.8	80.26
September 30	12.08	12.4	13.50	12.4	76.70
October 6	9.87	11.6	14.04	12.9	81.15
October 13	13.20	10.9	14.82	13.6	86.66
October 28	18.59	23.5	15.40	14.2	77.38
Average	13.0	14.4	14.6	13.4	80.43

[a] Approximate estimate made at Washington, D. C. [b] Calculated at Washington.

Only the temperature and precipitation records were available for Logan, and in connection with these a full set of meteorological data for Salt Lake City, about 66 miles south of the experiment station, is given.

Meteorological data for Logan, Utah.

Month.	Mean temperature.	Precipitation.
1902.	° *F.*	*Inches.*
May	55.5	2.19
June	65.4	.74
July	68.4	.52
Average and total	59.8	3.45
August	70.5	.27
September	60.4	Trace.
October	41.4	.51
Average and total	60.8	.78
General average and sum total	60.3	4.23

Meteorological data for Salt Lake City, Utah.

Month.	Mean temperature.	Precipitation.	Sunshine.			Clear days.	Cloudy days.
			Actual.	Possible.	Per cent.		
1902.	° *F.*	*Inches.*	*Hours.*	*Hours.*			
May	59.2	0.33	308.0	449.1	69	15	6
June	69.4	.37	367.1	451.9	81	19	2
July	72.5	.56	372.4	458.6	81	22	4
Average and total	67.0	1.26			77	56	12
August	74.6	.15	330.4	427.4	77	19	3
September	64.1	.05	302.4	374.0	81	20	5
October	55.2	.52	280.6	343.9	82	21	5
Average and total	64.6	.72			80	60	13
General average and sum total	65.8	1.98			78.5	116	25

The results of the collaborative experiments at Utah show the production of a crop of about average tonnage, or at least what the average tonnage should be, a fair content of sugar, and a purity which reaches the standard for successful and profitable sugar manufacture.

The average temperature of the six growing months was 60.3°. August was the warmest month, its average temperature being 70.5°, while October was quite cool, having an average temperature of 41.4°. The precipitation was deficient except for the month of May, and the total amount of rainfall was only 4.23 inches for the six months.

GENERAL REMARKS.

The data from the irrigated sections are interesting in many respects as compared with those from the stations where irrigation is not practiced. In the first place it is evident that the extremes of heat which are experienced in the nonirrigated areas are avoided at the irrigated stations where the temperature is more equable, less prone to reach extreme maxima, and thus should be favorable, according to the results of our investigation, to securing a high content of sugar. And the figures show that the average percentage of sugar in the beets from the irrigated areas is 2.4 per cent higher than that of the other stations.

There was a marked deficiency in the rainfall at the California stations, while in Colorado the total amount of rain would have been sufficient to produce a fair crop had it been properly distributed throughout the growing season instead of one-half of it falling in a single month, namely, September, when it would probably be detrimental to the maturing of the beet.

By reason of the high altitudes there is danger of unseasonable lowering of the temperature, as was shown especially in Colorado, where severe frosts sufficient to check growth occurred in September. It is evident that latitude abstractly has little to do with the climatic con-

ditions which prevail in most of the arid areas because by reason of the influence of the sea on the western coast and the high altitudes of the plateaus, which form the greatest part of the surface of the arid States, the isothermal lines are greatly disturbed in their relation to the parallels of latitude. We have thus introduced into the study of these stations a seriously disturbing factor, the influence of which must be determined by further investigation. The more extensive data which we hope to receive during the next two years from these irrigated areas will form a basis for the solution of this important question.

As only three of the irrigation stations took part in the experiment and the work has only just been systematically inaugurated no attempt is made to represent the data collected in graphic form.

THE SOILS.

The following data, reported by the cooperating stations in regard to the soils on which the beets were grown, are submitted, although they are of rather a fragmentary character. Nevertheless, they are of interest in connection with the chemical and mechanical analyses of such samples as were received for 1902 and the data obtained in 1901.[a]

DESCRIPTIVE NOTES ON SOILS.

UNIRRIGATED SOILS.

AGRICULTURAL COLLEGE, MICH.

[Nos. 25106 and 25107.]

Director Smith sent the following notes on the sampling of soils at the Michigan station:

The experimental plat is from the center of a larger plat which has borne no crop at all since 1900. We made an attempt to get the soil sample from another part of the plat, but found the conditions so irregular that we had to go to another part of the area. Here we found the soil proper to be but 6 inches deep, the depth of the plowing for the years the plat has lain fallow. The subsoil was rather irregular, as it is bound to be here in the glacial region. A few years ago I made a topographical survey of certain plats on this area on which the varying yields of contiguous plats had indicated some peculiar conditions, and found that the subsoil rose and fell in waves, the crests of which were approximately a rod apart with a height of 6 feet.

The experiments were made on Nos. 33 and 35 of the station plats. These plats are 8 rods long and 2 rods wide. A subplat 60 feet on each side was laid off on the southern part of the plat, the south line being approximately the south line of the plats and the east line of plat No. 33. From the center of this plat a sample of soil was taken for analysis at Washington. From 1891 to 1899, inclusive, oats were grown on these plats with the exception of the years 1893 and 1899, when wheat was planted.

[a] U. S. Dept. Agr., Bureau of Chemistry Bul. 74, The influence of soil and climate upon the composition of the sugar beet.

ITHACA, N. Y.

[Nos. 24898 and 24899.]

The soil used for this year's experiment is a gravelly loam. It lays at the foot of a knoll and is naturally more fertile than the average soil of the field, but it has had no manure for several years.

GENEVA, N. Y.

[Nos. 1754 and 1755 S. and F].

The soil on which the beets were grown is a clay loam used in a five-year rotation, as follows: 1897, oats; 1898, wheat seeded to clover and timothy; 1899, clover and timothy, first cutting; 1900, clover and timothy, second cutting; 1901, Indian corn or maize.

BLACKSBURG, VA.

[Nos. 25104 and 25105.]

The character of this soil, its fertilization, etc., have been described under the agricultural data given for the Virginia station. The detailed account of the taking of the soil samples as forwarded by Mr. Alwood is as follows:

Opening No. 1.—The top soil, 10 inches deep, grayish, dark, almost slate colored, shows many pebbles and a considerable quantity of humus present. Soil is very mellow down to the subsoil. The line of demarcation between the soil and the subsoil is very distinct. The subsoil at this place is an ochreous yellow, decidedly clayey in texture, and quite moist, firm, but not hard.

Opening No. 2.—The top soil, 12 inches deep, had the same color and appearance as the above; very mellow, humus matter quite abundant, line of demarcation very distinct. Subsoil, gray in color and of very fine texture, was compacted into a tight hardpan, extremely dry and very hard.

Opening No. 3.—The soil was the same as No. 2, 12 inches deep. The subsoil was still harder than No. 2, very dry and with the same general color.

The season was extremely dry and it appears that the ground water failed to rise through the subsoil at the last two openings. At the first opening the ground water was very evident in the subsoil.

MADISON, WIS.

[Nos. 25108 and 25109.]

The soil is a clay loam with a heavy clay subsoil. It has a strong tendency to bake after rains, a thick solid crust being then formed on the surface.

IRRIGATED SOILS.

POMONA, CAL.

At Pomona station the sugar-beet soil is a sandy loam, free from alkali. The chemical character of the soil is the same as that of the Pomona station tract in general, except that it is more diluted from the admixture of a larger proportion of sand, thus diluting the plant

food to some extent. An analysis of the soil from the beet plat is as follows:

	Per cent.
Coarse materials > 0.55 mm	33.00
Fine earth	66.00
Chemical analysis of fine earth:	
Insoluble matter	68.40
Soluble silica	10.29
Potash (K_2O)	.89
Soda (Na_2O)	.42
Lime (CaO)	2.53
Magnesia (MgO)	1.84
Oxid of manganese (Mn_3O_4)	.02
Peroxid of iron (Fe_2O_3)	7.13
Alumina (Al_2O_3)	4.41
Phosphoric acid (P_2O_5)	.23
Sulphuric acid (SO_3)	.03
Carbonic acid (CO_2)	.08
Water and organic matter	3.21
Total	99.48
Humus	.58
Humus ash	.40
Humus nitrogen (per cent in humus)	1.16
Soluble potash (citric acid method)	.058
Soluble phosphoric acid (citric acid method)	.05

At Chino station (unirrigated) the soil is somewhat heavier in character than at Pomona, and more retentive of moisture as well as more fertile. The tract has been subdivided and in each subdivision the alkali content has been determined.

FORT COLLINS, COLO.

[Nos. 25060 and 25061.]

The following comments on the soil conditions existing at the Colorado station are taken from the report made by Mr. Danielson:

The ground on which these beets were grown was planted to potatoes the previous season (1901). The potatoes had received no water and only one cultivation. On the west side of the plats the potatoes had been fertilized with bone meal and nitrate of soda in strips running north and south. The beets were planted across these fertilized strips, so as to give all the varieties uniform treatment.

A mass analysis is given of soil from the station farm from a field not far distant from the one on which these beets were grown, and probably very similar. The analysis was made by W. P. Headden.

	Per cent.
Silicic acid	69.356
Sulphuric acid	.041
Carbonic acid	.016
Chlorin	.006
Phosphoric acid	.466
Potash	2.248
Soda	1.215

	Per cent.
Lime	1.645
Magnesia	1.412
Ferric oxid	5.424
Manganic oxid	.160
Moisture at 110° C.	2.981
Ignition	4.044
	100.352
Oxygen eq. chlorin	.001
	100.351

Samples of the soil and subsoil taken in the middle of the growing season from the area on which these beets were grown were forwarded to Washington.

ANALYSES OF SOILS.

The chemical and mechanical analyses of the samples of soils and subsoils forwarded to Washington from the various stations were made in the Bureau of Chemistry and in the Bureau of Soils of this Department, respectively, and the results are shown in the following table:

Chemical analyses of sugar-beet soils, 1902.

[Percentages based on water-free soil.]

Serial No.	Locality.	Description.	Insoluble.	Volatile.	Nitrogen (N).	Soluble in 1.115 sp. gr. HCl.					Soluble in N/200 HCl. Parts per million.	
						Potash (K_2O).	Lime (CaO).	Magnesia (MgO).	Fe_2O_3, Al_2O_3, Mn_3O_4.	Phosphoric acid (P_2O_5).	Phosphoric acid (P_2O_5).	Potash (K_2O).
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*		
25100	Lexington, Ky.	Soil	80.96	8.25	0.24	0.28	0.75	0.40	8.48	0.75	7.0	51.6
25101	do	Subsoil.	85.20	5.58	.14	.08	.59	.35	7.44	.50	.....	.....
25106	Agricultural College, Mich.	Soil	89.40	4.85	.11	.25	.62	.36	4.50	.09	2.0	37.0
25107	do	Subsoil.	92.79	2.15	.03	.28	.38	.39	3.20	.03	.....	.....
24898	Ithaca, N.Y. (Cornell).	Soil	87.58	7.30	.17	.21	.35	.45	3.09	.18	10.7	114.0
24899	do	Subsoil.	83.74	4.00	.06	.66	2.00	.84	8.03	.09	.....	.....
1754 (S. & F.)	Geneva, N. Y.[a]	Soil	81.70	8.00	.17	.56	.56	.82	8.34	.09	1.0	87.0
1755 (S. & F.)	do	Subsoil.	80.35	5.60	.10	.89	.81	1.27	10.91	.09	.....	.....
25104	Blacksburg, Va.	Soil	87.03	4.32	.17	.30	.19	.38	6.67	.14	5.0	249.6
25105	do	Subsoil.	87.30	2.90	.03	.36	.16	.47	8.62	.07	.....	.....
25108	Madison, Wis.	Soil	85.76	5.80	.13	.38	.61	.45	5.52	.16	26.0	48.0
25109	do	Subsoil.	85.30	5.00	.06	.44	.46	.67	8.00	.11	.....	.....
25125[b]	Washington, D.C.	Soil	83.47	5.35	.18	.39	.47	.51	8.27	.03	.....	.....
	Irrigated soils.											
25060	Fort Collins, Colo.	Soil	73.01	10.20	.18	.73	5.40	1.11	9.01	.18	3.5	144.6
25061	do	Subsoil.	65.39	12.50	.11	.54	10.16	1.27	9.35	.17	.....	.....
1756 (S. & F.)	Logan, Utah[c]	Soil	78.46	13.50	.10	.73	6.82	4.34	6.27	.22	25.0	394.8

[a] Samples taken after crop was grown.
[b] Analysis made in 1901. Same plat planted in 1902. Soil only analyzed.
[c] No subsoil sent, as plat is very shallow and underlaid with gravel.

Mechanical analyses of sugar-beet soils, 1902.

Serial No.	Locality.	Description.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
25100	Lexington, Ky	Soil	3.08	0.06	1.30	1.36	1.04	1.76	75.90	18.58
25101	do	Subsoil	1.43	0.00	.98	.50	.56	1.24	76.72	19.10
25106	Agricultural College, Mich	Soil	2.58	2.30	4.48	9.16	33.96	14.36	27.12	8.62
25107	do	Subsoil	.54	1.14	4.84	9.80	32.80	16.88	21.06	13.48
24898	Ithaca, N.Y. (Cornell)	Soil	3.42	.60	5.80	6.50	27.20	24.84	20.30	14.88
24899	do	Subsoil	1.34	0.00	3.08	3.90	31.06	34.00	17.46	10.26
1754 (S. & F.)	Geneva, N.Y.	Soil	2.22	4.88	4.36	3.36	10.26	17.98	29.84	29.30
1755 (S. & F.)	do	Subsoil	.68	3.10	4.40	3.50	9.80	16.80	27.10	35.02
25104	Blacksburg, Va	Soil	1.82	3.56	3.52	2.44	6.58	10.10	58.62	15.18
25105	do	Subsoil	1.23	3.68	3.00	2.36	5.70	8.84	55.64	20.78
25108	Madison, Wis	Soil	3.14	0.00	1.30	2.20	7.40	6.40	65.50	16.74
25109	do	Subsoil	.78	0.00	.80	1.40	5.62	6.00	65.60	20.56
25125[a]	Washington, D.C.	Soil	1.63	.34	1.52	2.94	16.78	24.00	33.02	21.40
	Irrigated soils.									
25060	Fort Collins, Colo	Soil	2.52	.08	3.28	3.14	13.92	24.26	36.12	19.20
25061	do	Subsoil	1.09	.06	2.28	1.98	9.48	22.20	38.86	24.90
1756 (S. & F.)	Logan, Utah	Soil	5.83	1.10	1.60	1.94	22.80	35.16	22.58	14.80

[a] Analysis made in 1901. Same plat planted in 1902. Soil only analyzed.

COMMENT ON ANALYSES.

The data of the soil analyses are calculated to the water-free substances with the exception of water of composition. A general comparison of the soils of the irrigated and nonirrigated stations shows a larger percentage of insoluble matter in the first named than in the latter. On the other hand, the irrigated soils show a larger percentage of volatile matter than the nonirrigated. It is evident that the irrigated soils are more highly basic and the nonirrigated soils more highly acidic in character. The irrigated soils have a much higher average percentage of potash than the nonirrigated, and, with the exception of the soil from Lexington, they have a higher average content of phosphoric acid. The most marked difference, however, in the two sets of soils is in the quantity of lime contained, the irrigated soils showing a very much larger proportion of this important element. This is easily explained when it is remembered that lime compounds, especially the carbonate, are quite soluble in water carrying carbon dioxid, and thus the lime is more thoroughly leached from rain washed, nonirrigated soils. The large quantities of lime and potash present in the irrigated soils can not fail to be of lasting benefit to such a crop as the sugar beet. Potash furnishes a most important part of the food of the beet, while the lime tends to favor the conditions producing maximum nitration of the organic nitrogenous bodies which the soil may contain.

The irrigated soils, when treated with dilute cold hydrochloric acid, show larger quantities of potash than the nonirrigated, with the excep-

tion of the soil from Blacksburg, Va. The latter soil, although it does not have a very large percentage of potash, evidently holds it in a state easily assimilated by growing crops.

The nitrogenous content of the soils is quite uniform, but in some of the subsoils, as for instance those from Michigan and Virginia, the content of nitrogen is very low. Phosphoric acid is not very abundant in any of the soils except that from Lexington, Ky., which is well known as a carrier of large quantities of this important plant food.

The mechanical composition of the soil shows some interesting variations in the distribution of the materials of different degrees of fineness. The soil from the Lexington station is found to be three-fourths silt while that from the Ithaca station is only one-fifth silt. The soil from the Geneva station, where the richest beets are produced, is composed of almost one-third silt. In general it may be said that so large a proportion of silt as is found in the Lexington soil would tend to produce a seed bed somewhat too compact for the development of a beet of the best quality. Yet we find in the soil from Madison, Wis., that the percentage of silt is only 10 per cent less than that at Lexington. The yield of beets, however, at Madison and the content of sugar therein were both extremely satisfactory.

The organic matter varied greatly in the different soils, being present in the largest quantity in the sample from Logan, Utah, and the smallest in the soil from Washington, D. C., the latter being an artificial soil made from the materials dredged from the bottom of the Potomac River. Among the subsoils the one having the least organic matter was that from the Michigan station and the highest content was found in the sample from the Kentucky station.

SUMMARY OF DATA.

Agricultural and analytical data, 1902.

Station.	Mean weight of topped beets.	Estimated yield per acre.	Sugar in beet.	Coefficient of purity.
	Ounces.	*Tons.*	*Per cent.*	
Lexington, Ky	8.0	8.9	7.3	70.9
Washington, D. C	22.9	26.1	8.4	72.4
Blacksburg, Va	15.4	[a]16.7	11.7	74.4
Ithaca, N. Y	17.0	18.0	12.5	81.9
Madison, Wis	24.2	31.8	12.7	82.0
Agricultural College, Mich	10.6	12.5	13.5	86.9
Geneva, N. Y	14.3	16.1	13.9	84.5
Irrigation stations.				
Fort Collins, Colo	19.7	24.0	13.0	79.4
Logan, Utah	13.0	14.4	13.4	80.4
Pomona, Cal		5.0	15.0	86.5

[a] Estimated on 50 feet of row harvested September 1 and 19.

Yield and soil data, 1902.[a]

Station.	Yield per acre.	Chemical analysis.			Mechanical analysis.		
		Potash.	Nitrogen.	Phosphoric acid.	Total sand.	Silt.	Clay.
	Tons.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Lexington, Ky	8.9	0.18	0.19	0.63	4.37	76.31	18.84
Agricultural College, Mich	12.5	.27	.07	.06	63.14	24.09	11.05
Geneva, N. Y	16.1	.73	.14	.09	35.23	28.47	32.06
Blacksburg, Va	16.7	.33	.10	.11	21.27	57.13	17.98
Ithaca, N. Y	18.0	.44	.12	.14	68.19	18.88	12.57
Washington, D. C.[b]	26.1	.39	.18	.03	45.24	33.02	21.40
Madison, Wis	31.8	.41	.10	.14	15.56	65.55	18.65
Irrigated soils.							
Pomona, Cal.[c]	5.0	.89	.....	.23	.....	.....	.....
Logan, Utah[d]	13.0	.73	.10	.22	61.50	22.58	14.80
Fort Collins, Colo	24.0	.64	.15	.18	40.27	37.49	22.05

[a] Average of figures for soil and subsoil as platted on charts are given.
[b] Soil only for 1901.
[c] Determined at California station; only humus nitrogen given.
[d] Soil only.

Meteorological data, May to October, 1902.

Station.	Temperature.	Precipitation.	Clear days.	Cloudy days.	Sunshine.
	°*F.*	*Inches.*			*Per cent.*
Lexington, Ky	69.3	16.6	83	22	76.1
Washington, D. C	68.6	23.5	80	25	67
Blacksburg, Va	65.8	15.2	74	46	.....
Ithaca, N. Y	60.4	23.3	41	54	.....
Madison, Wis	61.8	24.6	38	76	.....
Agricultural College, Mich	60.5	27.4	55	67	[a]58
Geneva, N. Y.[b]	63.1	20.2	.....	.....	.....
Irrigation stations.					
Fort Collins, Colo	60.0	14.8	94	32	[c]62.5
Logan, Utah	60.3	4.2	[d]116	[d]25	[d]78.5
Pomona, Cal	70.0	.59	67	6	[e]70

[a] Sunshine data for Detroit, Mich.
[b] Data for May observed at Lyons.
[c] Sunshine data for Cheyenne, Wyo.
[d] Report for Salt Lake City, Utah.
[e] Report for Los Angeles, Cal.

Geodetic data.

Station.	Average length of day.[a]	Latitude.[b]	Altitude.[b]
	h. *m.*	° ′ ″	*Feet.*
Lexington, Ky	14 18	38 02 25	979
Washington, D. C	14 23	38 53 23	37.5
Blacksburg, Va	14 14	37 14 00	2,100
Ithaca, N. Y	14 41	42 27 00	810
Madison, Wis	14 44	43 04 36	955
Agricultural College, Mich	14 42	42 45 00	847
Geneva, N. Y	14 44	42 53 00	453
Irrigation stations.			
Fort Collins, Colo	14 32	40 35 00	4,994
Logan, Utah	14 37	41 44 00	4,506
Pomona, Cal	13 58	34 3 00	861

[a] These figures cover from May to August, inclusive, and are furnished by the U. S. Naval Observatory.
[b] Data furnished by the U. S. Coast and Geodetic Survey.

CONCLUSIONS.

The results of the investigations of 1902 confirm in a general way those of the two previous years. As is to be expected, however, the great seasonal changes which take place from year to year at the different stations introduce important variations in the chemical composition of the crop. For the third time in succession, however, the station at Geneva holds first place in respect of the content of sugar.

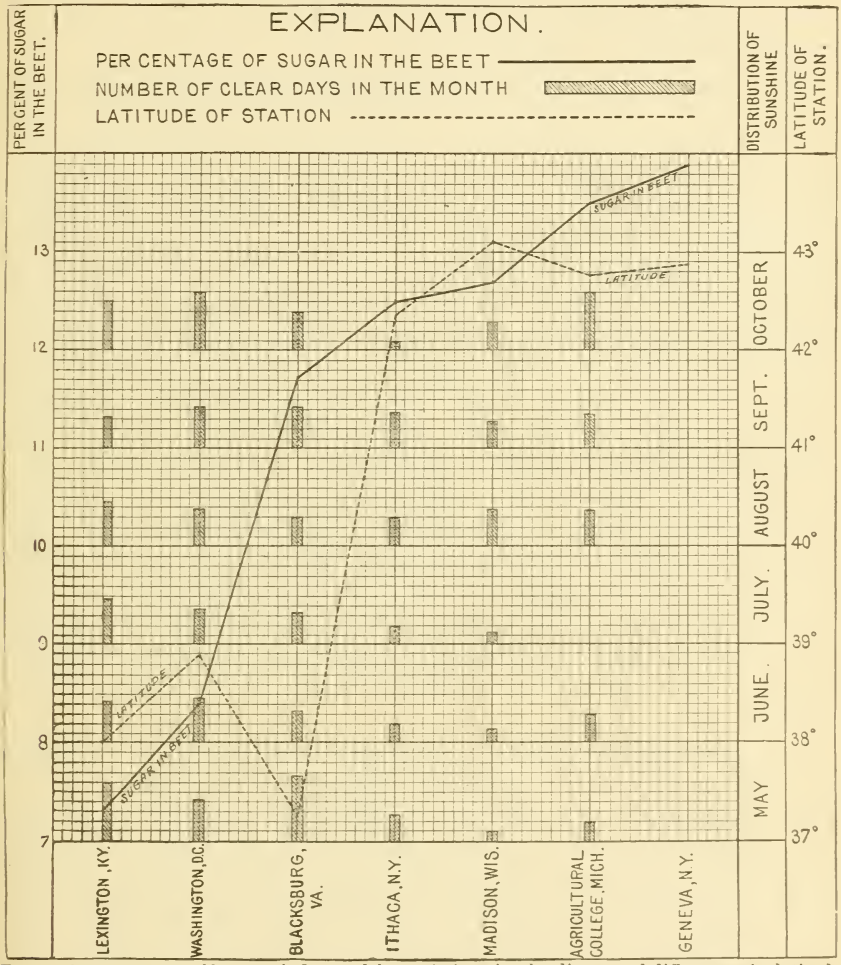

FIG. 1.—Sugar content of beets as influenced by variations in cloudiness and differences in latitude of experiment stations.

Michigan has advanced to second place, after having been tied with the stations of Ithaca and Lafayette in 1901, for that position.

The chart (fig. 1) shows the percentage of sugar in the beet, the number of clear days in the month during the growing season, and the latitude of the station. By reason of the fragmentary nature

of the data for the percentage of sunshine the curve representing this element of the environment has been omitted. As in the two previous years, there is a general agreement in the curves showing the percentage of sugar and the latitude. The one important exception is found in the Blacksburg station, and this is fully explained by reason of the high altitude of this locality, which acts in the same manner as a high latitude. Were it not for the varying length of the day a more definite relation could be established by comparing the sugar content of the beet with the mean isothermal lines for the period of growth, instead of with the latitude.

The number of clear days was very evenly distributed between the growing months at Lexington, Washington, and Blacksburg and quite unevenly distributed at the other stations for which these data were reported. In our previous reports attention was called to the fact that unobstructed sunshine is not absolutely necessary to the normal development of the sugar content of the beet.[a] Some recent studies made in Germany on the influence of certain factors of the environment upon the composition and yield of sugar beets, by Dr. O. Vibrans, of Helmstedt,[b] confirm the conclusions published by this Bureau in regard to the effect of cloudy weather upon the quality of the beet.

The author states that it has long been supposed that in order to secure a normal evolution of the sugar beet and a favorable harvest continued warmth and sunshine are necessary in addition to the requisite moisture. The season of 1902, however, characterized as it was by excessive cloudiness and precipitation, showed that these conditions, especially as bearing upon the quality of the beet, are not necessarily detrimental. It is stated, however, that the result of the harvest showed a diminished yield in spite of the fact that a sufficient quantity of moisture was received during the growing season and although the fields were well cultivated, normally fertilized, and the beets carefully watched.

These observations bear out the conclusions which we have drawn from our studies to the effect that the sun's rays when the sky is covered with clouds are still able to influence the functional activity of the chlorophyll cells in such a way as not to diminish the percentage of sugar in the beet. In fact during the very hot days of summer such a screening of the sunlight may prove beneficial. Vibrans says:

> The weakening of the total intensity of the sun's action by the particles of water and dust which may be in the air is greatly increased in the case of clouds. If a cloudy condition continues for some time the sun's rays nevertheless, as has been said, continue to exert their influence on the plant. This has been shown by the peculiar phenomena which were manifested during the past year (1902), when it was

[a] U. S. Dept. Agr., Bureau of Chemistry Bul. 64, p. 30, and Bul. 74, p. 37.

[b] Centralblatt für die Zucker-Industrie, No. 33, May 16, 1903, p. 809, and No. 34, May 23, p. 829.

noticed that those sugar beets which were particularly rich in sugar had developed an excessive leaf growth. From this the conclusion can be drawn that the leaves which were at first developed by the beet were not sufficient to produce a normal development with the quantity of light at their disposal. The dormant buds, therefore, woke into activity and produced the additional leaves required. Thus a more extended leaf surface was created and the light could thus engender the necessary activity to develop new vital processes.

It is further shown that this increase of leaf surface which permits the assimilation process to go on unhindered in cloudy weather is not noticed in conditions of artificial shade which tend to produce etiolation—as, for instance, on the edges of forests. In such cases the leaf stems are unduly lengthened, thin, and weak, and the leaves do not reach normal size because those processes in the leaf cells which promote the formation of leaf surface do not develop normally. The result of this is that the processes of assimilation and condensation attending the activity of the chlorophyll cells in the formation of starch and sugar are not complete. Greater comparative quantities of nonsugars are formed and the value as well as the quantity of the beets produced is greatly diminished. The size of the beet leaf in relation to the stem is dependent on the quantity and intensity of the light, and the more refractive elements of the sun's rays appear to be most active in producing such growth.

In the case cited by Vibrans as to the effect of artificial shading of beets grown along a road bordered by thick, heavy, chestnut trees, he states that the beets not only had a lower sugar content, but also yielded a decreased tonnage. It appears, however, that Vibrans has probably fallen into some error in ascribing this diminution of both sugar content and tonnage solely to the shade of the trees. It is well known that trees draw upon the adjacent soil for nourishment and to this extent rob any cultivated plant that may be in the vicinity. A large number of the poorer quality of beets in that experiment may have been due, therefore, to the absorbing activity of the rootlets of the trees extending great distances under the growing crop.

On the chart (fig. 2, p. 44) are shown the percentage of sugar in the the beet, coefficient of purity of the juice, the temperature and the average length of day. Here again is seen the X-like figure—somewhat fantastic in shape this year, but still marked in character—formed by the lines representing the content of sugar, purity of juice, and length of day, with the line representing the temperature. The variations in the temperature curve are found chiefly at Ithaca and Geneva. At Geneva, especially during the present year, the temperature of the growing season was high, while at Ithaca it was the lowest of any recorded at the cooperating stations. The highest temperature observed was at Lexington, Ky. The data represented on Chart No. 2 are in general wholly confirmatory of those obtained in the previous years of the investigation.

On the chart (fig. 3, p. 45) are shown the percentage of sugar in the beet, the total rainfall and its distribution by months throughout the

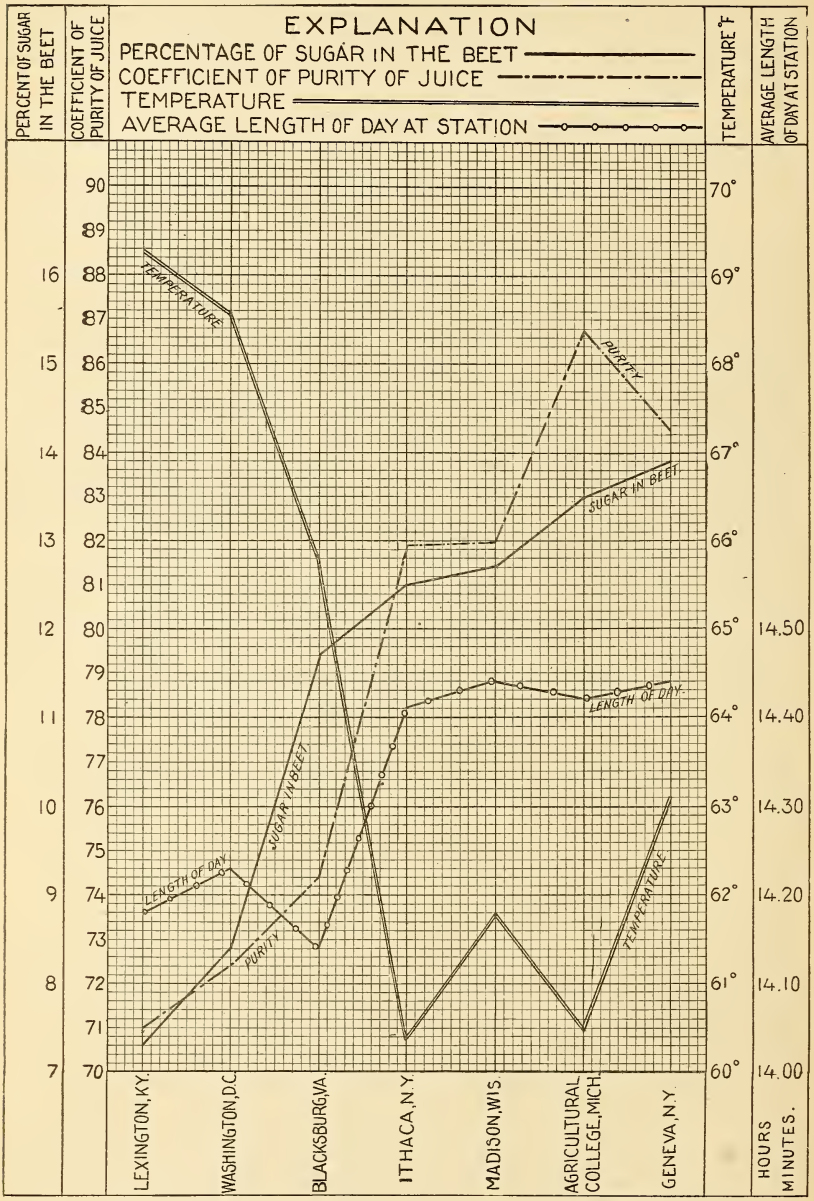

FIG. 2.—Sugar content of beets and purity of juice as influenced by temperature and light.

growing season, together with the altitude of the station. The most characteristic feature of this chart is the monumental curve showing

the altitude of the Blacksburg station. It is evident that altitude can only be considered in connection with the content of sugar in the beet

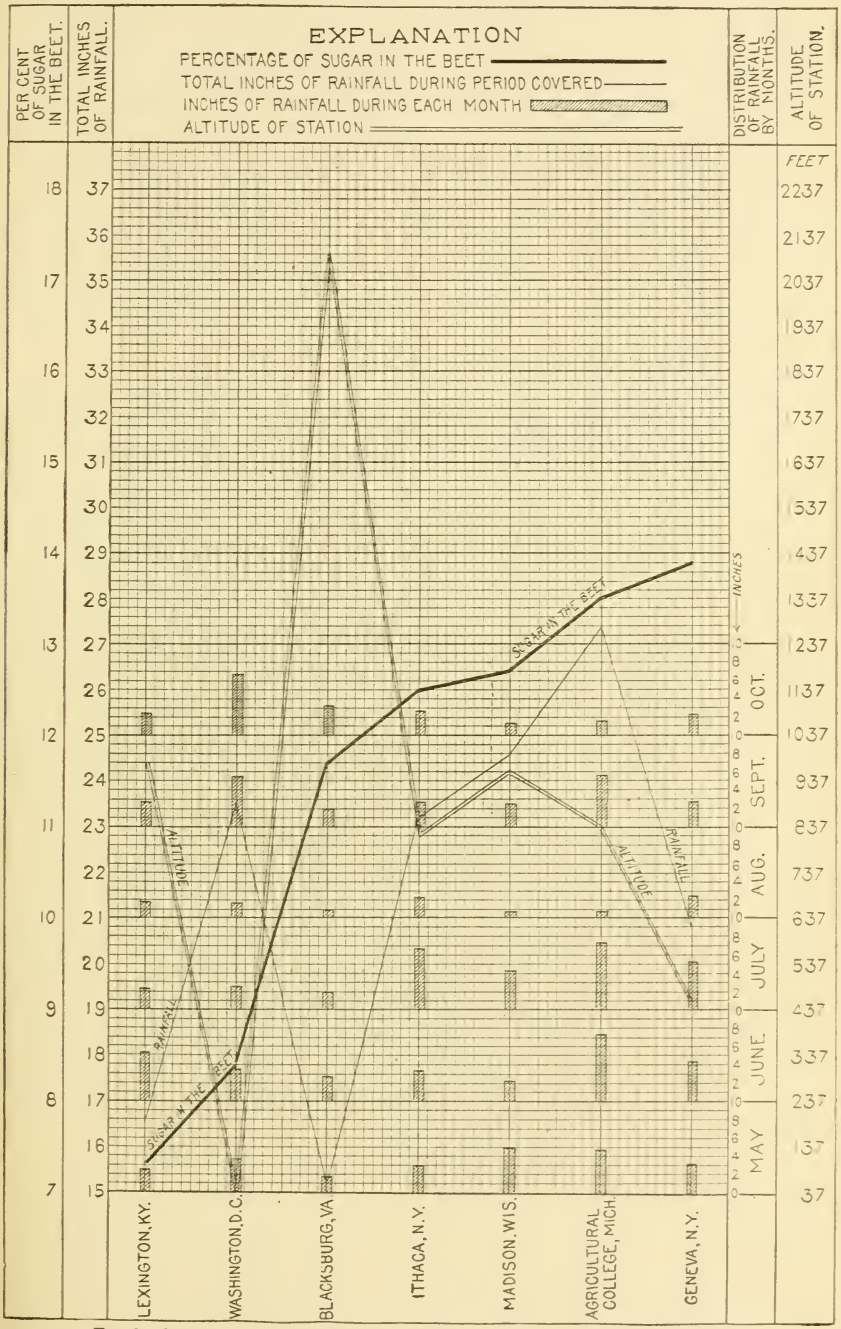

FIG. 3.—Sugar content of beets as influenced by rainfall and altitude of station.

when referred to some fundamental basis of comparison. there is a very marked tendency, however, for the high altitude to counteract

the influence of the low latitude. This is shown vividly by the chart in the case of Blacksburg, where by reason of the high altitude the content of sugar was raised far above what would be reasonably expected at sea level or on an extensive plateau at the same latitude.

The distribution of the rainfall is somewhat irregular, being most uniform at Lexington and Geneva, and least so at the Michigan station. In fact, the distribution of the rainfall at Geneva is extremely even, and while it is only reasonably so at Lexington the total amount is satisfactory. This chart gives additional testimony to the fact that under proper conditions of culture, and where the seed bed has been carefully prepared, not only the composition of the beet but also the yield per acre can be considered as largely independent of the distribution of the rainfall, provided there is sufficient moisture to meet the ordinary demands of the growing crop.

The chart (fig. 4, p. 47) shows the yield per acre and the average percentages of potash, nitrogen, and phosphoric acid in the soil and subsoil, the two figures having been combined, as the beets are deep feeders. The determination of potash, nitrogen, and phosphoric acid, according to the methods used, gives only a general indication of soil fertility, though the total absence of any one of these ingredients of plant food would make the production of a crop impossible. The presence, however, of even a small proportion of these foods, reckoned in per cent, indicates a sufficient quantity for many successive crops, if rendered available. The weight of the soil is so great compared with the weight of the crop that is produced upon it that a very few hundredths of a per cent of any one ingredient of plant food means an abundance of this ingredient for the production of the normal crop, provided it is in a form available for plant growth. At the station which had the largest yield per acre, namely, Madison, Wis., the phosphoric acid content was higher than at any other station except Lexington and Ithaca, being the same as at the latter station. The quantity soluble in dilute acid, however, was larger in the Madison than in the Lexington sample. The amount of potash was higher than at any other station except Ithaca and Geneva, while the nitrogen was lower than at any other station except Agricultural College, Mich., being the same as that at Blacksburg, Va. The lowest average percentage of nitrogen at any one of the stations was 0.07 at Michigan, and the highest was 0.19 at Lexington.

The presence of large quantities of two of the important plant foods does not indicate a large crop if a third important plant food is very deficient. This is shown in a marked degree at the Lexington station, which has the highest percentage of both phosphoric acid and nitrogen and the lowest percentage of potash of any of the stations, accompanied by the lowest yield. The yield per acre at Lexington could doubtless be greatly increased by the judicious applica

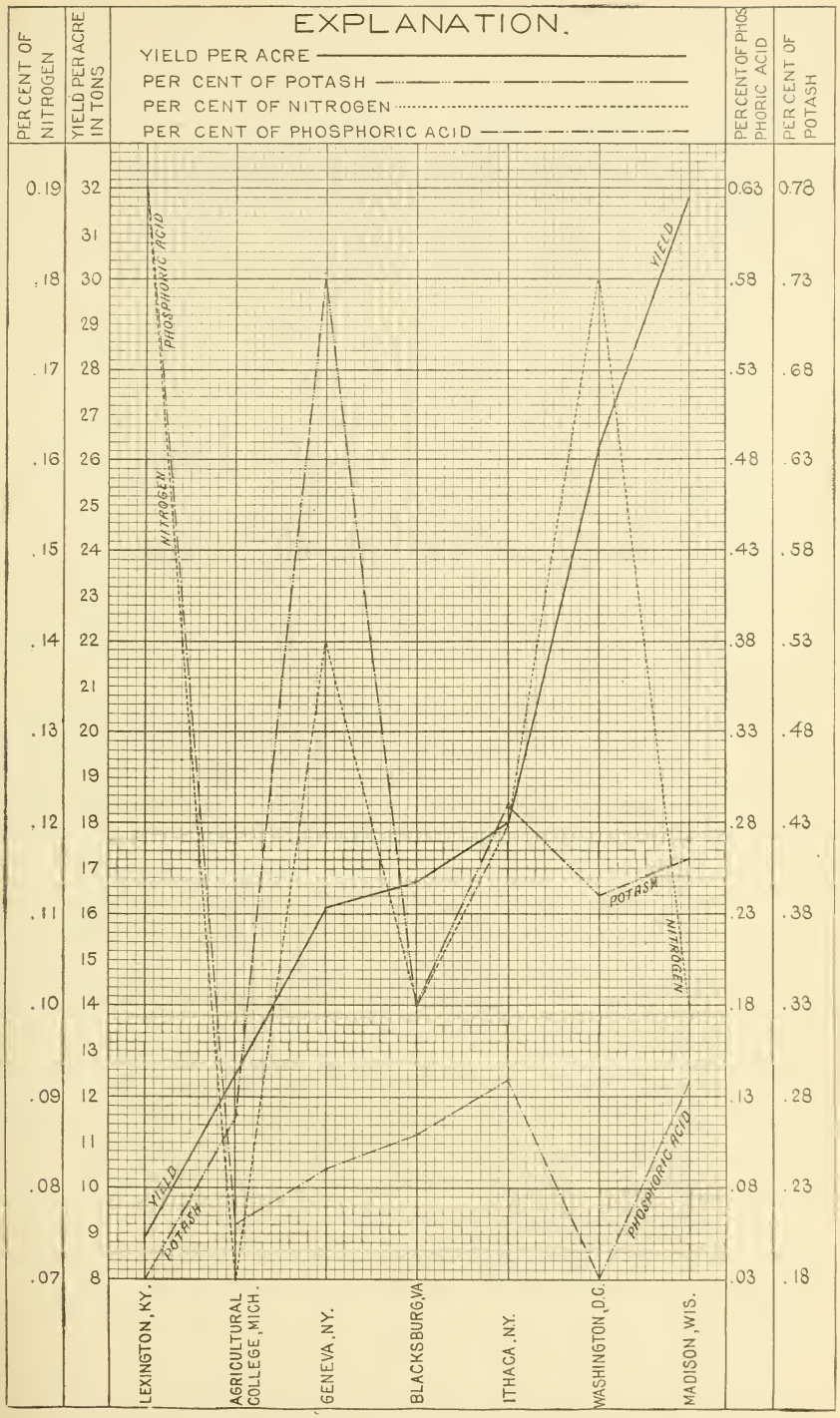

FIG. 4.—Yield of beets per acre as influenced by variations in the nutritive elements of the soil.

tion of potash. Nitrogen must be considered as of a more transitory nature than either potash or phosphoric acid. It exists most abundantly in the soils in the form of organic nitrogen which, though not available for plant food in that form, becomes so under the influence of nitrifying ferments. We have, however, a fine illustration of the influence of the deficiency of two elements of plant food at the Michigan station, where both phosphoric acid and nitrogen were very low, and the yield per acre was next to the lowest given. An apparent contradiction of this is found in the case of Washington, where, although the phosphoric acid was low, the yield was over 26 tons per acre. Both the potash and nitrogen, however, were abundant at the Washington station, and the phosphoric acid, having been derived from the bed of the river, though not large in quantity, was in a form to be readily assimilated. It is evident, however, that the data correlating the quantity of available plant food in a soil and the magnitude of the crop produced have their full value only when the meteorological conditions and all other elements of the environment are the same. This is convincingly illustrated by the results of the pot experiments conducted by this Bureau during the past decade which are now being prepared for publication. The complete failure of a crop on a soil well supplied with the necessary plant foods is described in the report from the Indiana station this year.

The chart (fig. 5, p. 49) shows the yield per acre and the average percentages of total sand, clay, and silt in the soil and subsoil. This chart, in so far as we know, is the first attempt to graphically illustrate the relation of the mechanical composition of the soil to the crop. The problem is so new and the data so fragmentary that we can not claim that much progress has been made in the attempt to elucidate any of the undeveloped principles, if there be such principles, which correlate the mechanical composition of the soil and the yield of the crop. It is evident that the mere mechanical state is not complete evidence of the availability of the plant food, but it is an indication as to whether or not the rootlets of the plant can have access to the nourishment which the soil contains. In general, it is true that the mechanical condition of a soil is highly important in determining the character of the crop which can be grown thereon. For instance, wheat is not the ideal crop for very sandy soils, nor melons and beets for those composed of stiff clay. We have, however, in the soils on which the beets of the present investigation were grown types of almost all kinds of soils, as far as mechanical structure is concerned, and the data obtained illustrate again, as has been developed in the former investigations, that the soil is the least important factor in the environment of the sugar beet in respect of sugar content.

A fundamental condition for the growth of beets is the preparation of the seed bed to a depth of at least 16 inches. Thus, even stiff clay

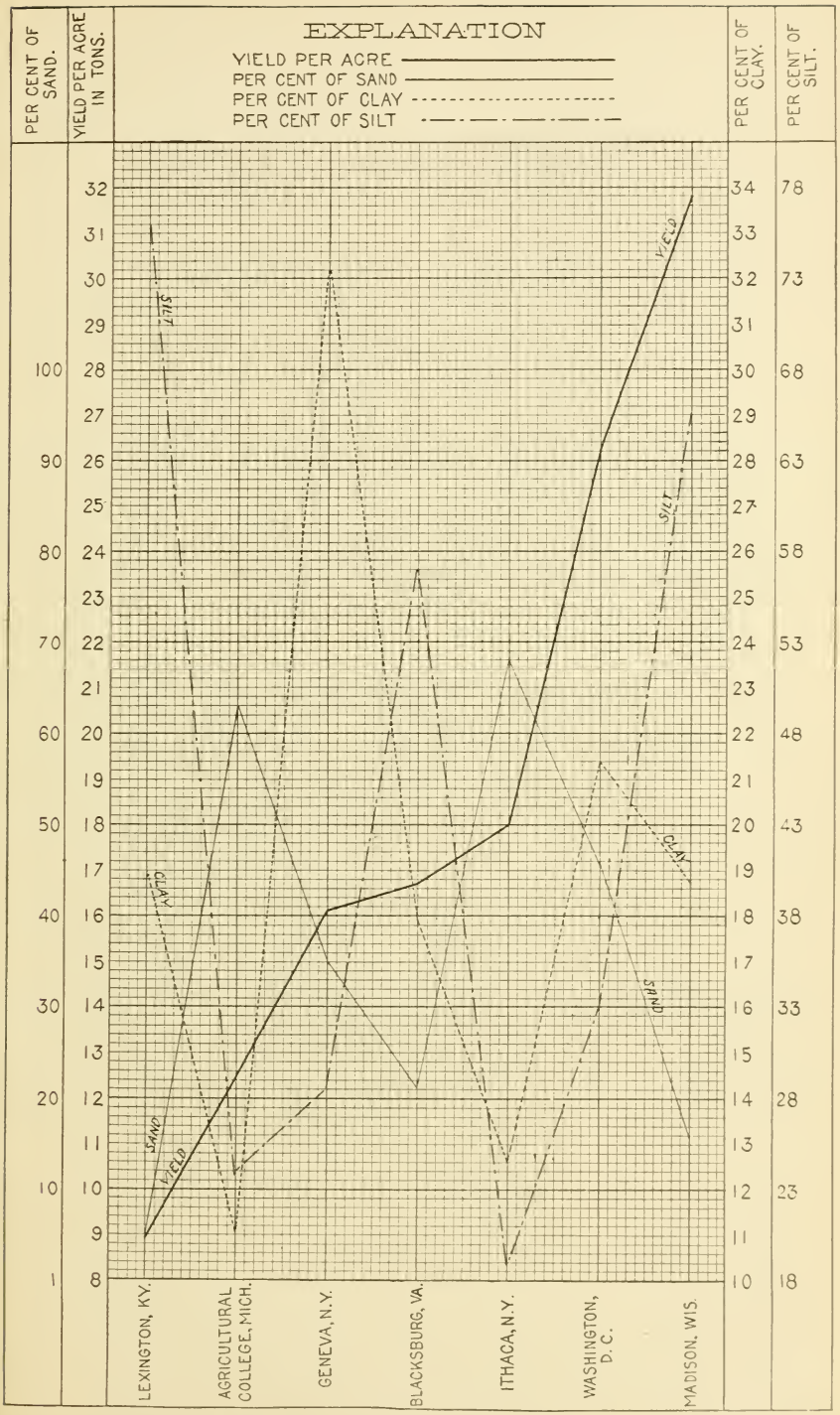

FIG. 5.—Yield of beets per acre as influenced by variations in physical composition of the soil.

when properly prepared is easily permeated by the roots of the growing beets. If a stiff clay soil be not properly prepared, then it is evident that beets could not do nearly so well in it as in a sandy soil; but when both kinds of soil are well prepared the beet grows well in each. It is evident, therefore, that the beet is not well suited to determine the influence of mechanical composition of the soil on the quantity of the crop. While a problem of this kind is very difficult, it is not beyond the possibility of solution, and it is believed that continued collection of data will throw light upon points which, so far as the beet is concerned, must now be considered as very dimly illuminated.